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## The Middle Eastern Hammadas

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Hammadas are a common feature of all desert areas of North Africa, the Middle East and Arabia. Large parts of the Sahara (1), of the Libyan Desert (20, 22, etc.), of the Arabian Desert, of the Syrian Desert, of the Sinai Desert (24) and of the desert parts of Palestine and Transjordan (25) are made up of Hammadas. Sometimes over half of the soils of such desert areas belong to the Hammada type, as in Wadi Arabia (25).



FIG. 1. Hammada near Kalath Aneze in Transjordan.

Hammadas are slightly rolling gravelly desert plains whose surfaces are strewn with vari-sized stone fragments and pebbles. Such fragments are brown or black, encased in the so-called "Schutzrinde" of German authors, regardless of whether the core itself is composed of chalk, granite, flint or schist. The brown and black surface of the pebbles shines brightly as it is covered by the "desert lacquer" whose composition and origin has been investigated by Walter, Leick and others. This black lacquer gave rise to the Arab legend that these stones were scorched by heavenly fires (1).

Stretching for miles on end, gleaming sombrely in the light of the sun, the Hammadas are doubtless among the most desolate spots on the earth (Figs. 1 and 2). Walter (22) in his classical book on deserts has described them impressively: "When the hot sunshine inundates the Hammada strewn with stone fragments each stone reflects the lightbeams as a small mirror and the eye is blinded by the violet shimmering gleam."

Hammadas can develop only under extreme desert conditions, i.e., in regions obtaining less than 100 mm. of annual rainfall (25), and are the most characteristic expression of desert climate (15). Brunhes already has



FIG. 2. Close up of Hammada near El Mushrife, Negueb.

described them as "le désert par excellence, le vrai désert . . ." (see 1, p. 36).

When seen in geological strata one may safely assume that this land was desert when the fossil Hammada was formed.

Hammadas have no continuous vegetation cover and belong to the few localities of the globe which are nearly plantless. Only 2 or 3 species of lichens are found on the ground, whereas vascular plants are mostly confined to slight depressions or rain gulleys. Although generally desert soils are quickly covered by a relatively rich flora of annual plants following one of the rare desert rains, Hammadas remain barren. Only Hammadas buried under sand support a limited vegetation. Zohary (25) refers to them as "sandy hammadas."

Our knowledge of Hammadas is sparse. Only Stocker (20) has investigated their ecology. On many trips to the deserts of Palestine, Transjordan,

Syria and Iraq we had ample opportunity to study Hammadas, sometimes several hundred square meters in areas extending over tens of kilometers. In 1940 we made an expedition to Sinai (24) where we were able to study some of the most interesting types of Hammadas. This paper is based on data collected by us on these trips.

At least 4 types of Hammadas can be recognized: The Grit Hammada, the Salt Hammada, the Non-saline Hammada and the Sand Hammada, and many transitions among these types.

#### GRIT HAMMADA

The top layer is represented by the same kind of gravel as described above. Under the gravel follows first a very thin (2-5) mm. layer of yellow

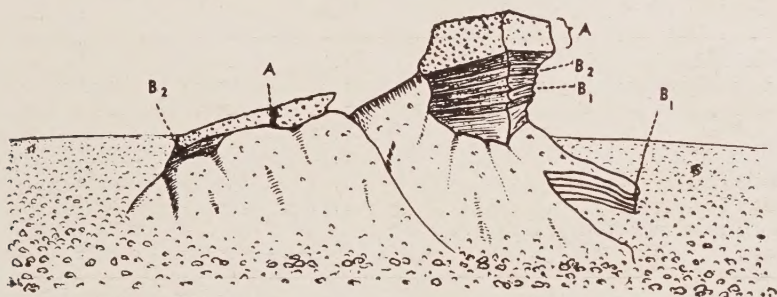


FIG. 3. Diagram showing genesis of Grit Hammada in Sinai.

sand, and under it a crumbly crystalline-edged white grit of varying depth, which on analysis proved to be a mixture of calcium sulphate (gypsum) and carbonate. In one place in Sinai, 88 km. east of Suez, we had an excellent opportunity to observe the genesis of this type of Hammada. As we were not allowed to take photographs at that time, a sketch must suffice for the explanation (Fig. 3).

A small hillock, supporting a free standing rock, protrudes from the Hammada. Its uppermost layer A is formed by a conglomerate of polished flints embedded in sand-cemented gypsum-carbonate grit. The same conglomerate forms the top of all surrounding hillocks. Under the conglomerate lie alternate layers of soft ( $B_1$ ) and hard ( $B_2$ ) sandstone.

The sand which weathers out of the sandstone is mostly carried away and forms the sand dunes of the sandy desert parts. Some sand remains, protected by a layer of stone fragments ("Panzerdecke" of German authors) from deflation by wind, and forms the uppermost layer of the Hammada. The gypsum-carbonate grit and the flint stones weather out from the gypsum-carbonate-cement layer. The flints, by selective deflation of all other elements, remain as a "protective layer" overlying the gypsum-

carbonate grit. The mother rock of the Hammada is of Miocene age and a formation of continental origin, appearing as if it were a fossil Hammada in the process of giving rise to recent Hammada.

The results of a chemical analysis of samples of Grit Hammadas from different localities are given in Table 1, which, shows only the most important data, namely, the water soluble salts, Cl, and NaCl and total N-content. The figures vary little: the total salt content between 0.99 and 1.54%, Cl (0.0066–0.0654%), NaCl (0.0109–0.108), whereas the N content is very low (0.0064–0.03%).

TABLE 1. *Soil analysis of Grit Hammadas*

Locality	Total of water soluble salts	Cl'	NaCl	N
Between Abou Zeneima and Ayoun Moussa	1.24	0.0103	0.0170	—
Between Abou Zeneima and Ayoun Moussa	0.99	0.0099	0.0163	0.03
Abou Zeneima	1.22	0.0176	0.0291	0.0064
Abou Zeneima	1.54	0.0654	0.108	0.017
Bir Hassana	1.35	0.0122	0.0201	—
Near Mitla Pass	1.20	0.0074	0.0122	0.010
Near Mitla Pass	1.22	0.0066	0.0109	0.014
Near Mitla Pass, near roots of <i>Haloxylon salicornicum</i>	0.083	0.0110	0.0182	0.021

All soil samples taken at depth of 15–20 cm.

Figures in % of Air Dry Soil.

All localities are situated in Sinai Peninsula.

The Grit Hammada is poor in Cl, apparently because of its coarse structure and the lack of fine capillaries preventing water from rising to the surface. As the grit layer is composed principally of sulphates, it contains much more sulphate than chloride in comparison with the Salt Hammadas.

Mechanical analysis shows a very small quantity of coarse and fine sand; clay and silt are almost completely absent.

The main geographical area where Grit Hammadas are found is the western part of the Sinai peninsula (Suez-Abu Zeneima, Suez-Kosseima). In Northern Sinai and in the Negeb (the South Palestinian desert) only small patches were encountered.

#### SALT HAMMADA

The top layer looks like that of the Grit Hammada. Under it follows a very thin layer (1–2 cm.) of fine powdery soil, often intermixed with stone fragments. Grit is completely absent.

Chemical analysis (Table 2) shows a much higher total of water soluble salts than in the case of the Grit Hammada (0.968–3.98%), and a much higher Cl (0.261–1.180%) and NaCl (0.436–1.940%) content. Whereas

TABLE 2. *Soil analysis of Salt Hammadas*

Locality	Depth of soil sample	Total of water soluble salts	Cl'	NaCl	N
Near Mitla Pass (Sinai)	15-20 cm.	1.80	0.261	0.436	0.006
Near Mitla Pass (Sinai)	15-20 cm.	2.56	0.501	0.830	0.013
Bir Hassana (Sinai)	15-20 cm.	1.74	0.643	1.062	0.019
El Hemade, near El Auja (Negev)	0 cm.	0.968	1.523	0.864	0.012
El Hemade, near El Auja (Negev)	10 cm.	3.77	1.140	1.880	0.014
El Hemade, near El Auja (Negev)	20 cm.	3.98	1.180	1.040	0.018
El Hemade, near El Auja (Negev)	30 cm.	3.71	1.138	1.880	0.013
El Hemade, near El Auja (Negev)	40 cm.	3.34	1.030	1.700	0.011
El Hemade, near El Auja (Negev)	50 cm.	3.25	0.925	1.525	0.008
Near El Mushrife (Negev)	0-10 cm.	2.43	0.608	1.003	—
Near El Mushrife (Negev)	25 cm.	3.03	0.883	1.455	—
Near El Mushrife (Negev) (near roots of <i>Zygophyllum dumosum</i> )	10 cm.	0.05	0.008	0.0138	—
Near El Mushrife (Negev) (near roots of <i>Zygophyllum dumosum</i> )	25 cm.	0.45	0.167	0.283	—
Near El Mushrife (Negev) (near roots of <i>Haloxylon articulatum</i> )	0-10 cm.	0.15	0.012	0.019	—
Near El Mushrife (Negev) (near roots of <i>Haloxylon articulatum</i> )	25 cm.	0.91	0.085	0.141	—

in the Grit Hammada NaCl represents only 0.9-1% of the total salts, the corresponding figures for the Salt Hammada are 24-49%. The N content is similar to that of the Grit Hammada.

The genesis of this Hammada was described by Walter (22), whose observations were readily confirmed by us. The stone fragments, forming the "Panzerdecke," are hard concretions of flint or other materials weathered out of their mother rock (often Eocene limestone). The wind carries away all soft particles and leaves only the bigger and harder concretions, which protect the underlying finer soil particles from further deflation. As in all arid climatic zones, the main movement of water is ascending. The water, evaporating on the soil surfaces, leaves behind salts—the reason for the high salt content of the Salt Hammadas.

Their mechanical composition is as follows: they contain a high percentage of coarse and fine sand, and are nearly devoid of silt and clay. A typical specimen examined by us yielded: 32.3% of coarse sand, 54.8% of fine sand, 11.3% of silt, no clay.

The Salt Hammadas are widely distributed. They are common in the Negeb, northern and north-eastern Sinai and in the desert parts of Trans-jordan. Stocker (20) described them from the Egyptian desert (Hammada Wadi Antonio with 2.59-4.83% water soluble salts, and Wadi Erodium with 1.24-3.61%).

## NON-SALINE HAMMADAS

The main difference between the Salt Hammadas and the Non-saline Hammadas lies in the fact that the latter contain a much lower percentage of water-soluble salts. This would still be a rather high salt content for any area other than a desert, but is quite low in comparison with Salt Hammadas. Another difference is evident from mechanical analysis, as Non-saline Hammadas are much richer in fine soil particles than Salt Hammadas, particularly in the surface layer. A typical example given by Zohary (25) illustrates this point well.

	0-10 cm.	10-20 cm.	20-30 cm.
Coarse sand	4.7	0.5	0.1
Fine sand	29.6	39.9	32.4
Silt	5.0	15.0	25.0
Clay	25.0	15.0	8.7

Most of the regs of North Africa seem to belong to this type of Hammadas. Killian and Féher (12) report an average of 0.071 and 0.122% of water soluble salts for these Hammadas and regs, and according to Killian their surface layers contain 26% clay and 23% fine clay. This high percentage of fine soil particles makes the reg's surface impermeable to water.

Zohary (25) described Non-saline Hammadas from Transjordan and Wadi Arabia. They seem to be very common in North Africa, where desert soils generally contain less salts than do the desert soils of Egypt and the Middle East, as pointed out by Killian and Féher (12) in regard to the Saharan desert: "Les sols salée sont bien plus rares."

## SAND HAMMADAS

According to Canon (1), another modification of Hammadas appears "whenever sand is strewn over its surface, even if the sand is only a few centimeters in thickness. This acts as an effectual mulch, increasing the retentive capacity of the soils and very strikingly changes the character of the vegetation" (p. 76). Zohary speaks of "sandy Hammadas" (25), if a shallow layer of sand covers gravelly ground and the sand contains much gravel. Such Hammadas are formed wherever a typical Hammada is protected from deflation by wind, and accumulation of sand is possible. As this sand is much poorer in water soluble salts than even the soil of the Non-saline Hammadas (mostly less than 0.05%), it constitutes a good substratum for plants. As a result it is the richest of the different types of Hammadas, as far as their plant cover is concerned. For the same reason sands are generally the "best" of the desert soils, provided they do not move too quickly.

## PLANTS AND HAMMADAS

As already mentioned, the Hammadas are mostly bare of plants, even after heavy rainfalls. If a plant cover is present it is extremely loose. Iso-

lated plants or small plant communities are found only in certain localities, distinguished by special topographic or edaphic conditions.

*Grit Hammadas*.—Plants are limited to places where, for some topographic reasons, bits of soil or sand accumulate. The dominant plants are *Haloxylon salicornicum* in western Sinai and *Anabasis articulata* in northern and north-eastern Sinai.

*Salt Hammadas*.—When flat, they are wholly barren. Plant life is concentrated in slight depressions and rain gulleys. The dominant plants are *Haloxylon articulatum* and *Zygophyllum dumosum*.

*Non-saline Hammadas*.—Similarly, plants are found only in rain gulleys and small wadies. But in contrast to Salt Hammadas, even the flat parts are never completely barren. The dominant plant species is *Anabasis articulata*, accompanied frequently by *Salsola rigida*, *Gypsophila Rokejeka*, etc.

*Sand Hammadas*.—If the sand covering these Hammadas reaches a certain depth and is not too mobile, the plant cover is denser and more consistent than those of other types of Hammadas. The dominant plants are the same as in the Non-saline Hammadas. But if the sand covering is deeper, typical psammophytes appear (*Thymelaea hirsuta*, *Aristida plumosa*, etc.).

The question which interested us most was, why are most Hammadas, except the sand type, devoid of plants in their flat stretches, and why do only rain gulleys and depressions harbor plant life? As conditions for the different types of Hammadas vary, we have to consider them separately. Before doing so, two factors possibly involved in an explanation may be excluded, namely water content and pH of the soil.

At first sight one is inclined to think that locally a higher water content supports plants, whereas elsewhere the Hammadas are characteristically barren. But, as was pointed out by Stocker (20) and confirmed by us, that is never the case. Frequently the plant-bearing localities have even less water than the adjacent barren areas. As there is never a considerable difference in pH between the places bearing plants and the barren plain, pH likewise does not offer any explanation. In accordance with the findings of other investigators, for instance those of Killian, the pH of desert soils is always uniform and "... joue une rôle subordonnée comme facteur indicateur en pays arides" (10, p. 36).

*Salt Hammadas*.—The best explanation for this type of Hammada is found through a soil analysis. It shows that near the roots of plants growing in rain gulleys or depressions the Cl, NaCl and total salt content is always much lower than even a few centimeters away in the barren Hammada (Tables 1 and 2). The same difference was repeatedly observed. Stocker (20) reports identical facts from Egyptian Hammadas. There can, therefore, be no doubt that the salt content of the soil is connected with the distribution of plants in the Salt Hammadas. This also accounts for

the fact that plants are concentrated in rain gulleys and depressions. Here rain has leached out part of the salts, thereby enabling *Haloxylon* and *Zygophyllum* to grow there, whereas the high salt content prevents their growing on the flat parts of Salt Hammadas. Similar conditions have been found by us in parts of our deserts not referable to Hammadas, where the salt content of the soil is clearly the decisive factor governing the distribution of the vegetation (4, 5).

● The salts themselves are not as important as the tremendously high suction forces of these soils caused by the high salt content. The accompanying graph (Fig. 4) shows that clearly. We took air dry Salt Hammada soil

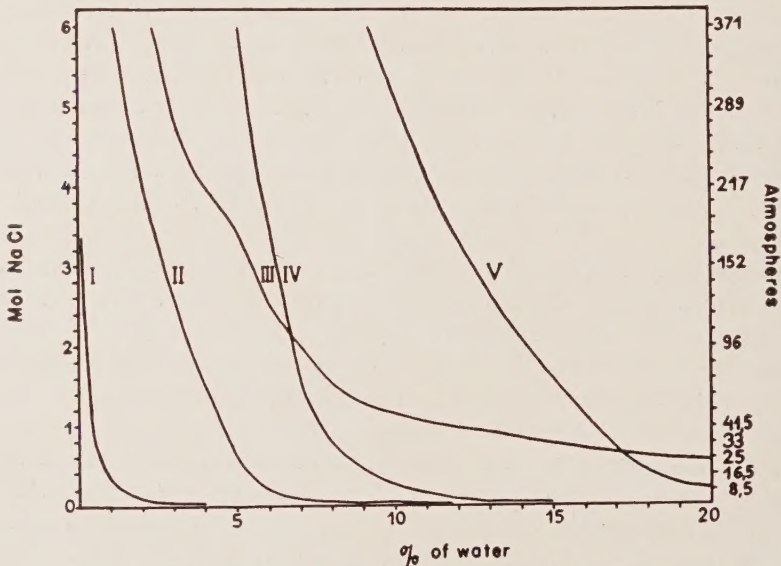


FIG. 4. Graph showing suction forces measured in Salt Hammada soils.

from two different localities (III and V) unchanged, and another sample from which all water soluble salts had been dissolved (II), and determined their suction force (with Hansen's method as modified by Stocker) adding ever-increasing quantities of water (each time 0.5 or 1 ml. of water was added to 100 g. of air dry soil), until these soils were fully saturated. For purposes of comparison, we treated typical terra rossa soil (IV) from hills near Jerusalem and a sandy soil from the seashore near Bat-Yam (I) according to the same method.

One of the Hammada soils, even when saturated after the addition of 28 ml. of water, retains a suction force of 12.48 atm., while the second one has a suction force of 8.5 atm. after the addition of 20 ml. of water. Terra rossa reaches the same suction force after the addition of only 10 ml. of

water, whereas its suction force drops below 0.43 atm. after another 6 ml. have been added (i.e., altogether 16 ml.).

When the salts are extracted from Hammada soil, it behaves almost like any sandy soil and attains a suction force of 0.43 atm. after an addition of 9 ml., whereas normal sandy soil reaches this point after 5 ml. of water have been added. This close resemblance between salt-free Hammada soil and sand is not astonishing, as mechanical analysis (see above) shows that 70–80% of Hammada soil is made up of coarse and fine sand.

The difference in the suction force of the same soil before and after the removal of its salts is very striking. Whereas the two Hammada soils when containing 5% of water show suction forces above 200 atm., Hammada soil free of salts has, under the same conditions, a suction force of only about 30 atm. When containing 10% of water, Hammada V still develops a suction force over 300 atm., and Hammada III a suction force of about 50 atm., whereas the salt-free Hammada soil at this water content has a suction force of less than 0.5 atm.

The graph also shows that the main factors responsible for the high suction forces of the Salt Hammadas are their high salt content and their physical structure. This is proved by the similarity of the suction force curves for pure sand and Hammada soils after the removal of their salts. This conclusion is in conformity with Stocker's investigations in the Egyptian desert (20).

*Non-saline Hammadas.*—The suction forces of these soils are also high, but not as high as those of the Salt Hammadas. Their salt content is lower than that of the Salt Hammadas, while their content in fine soil particles is higher. This offers the explanation for Harder's (8) observation in Beni Ounif. He found that after removal of the salts the suction forces of these soils are only slightly reduced. With a water content of 5% the suction force of these soils is about 30 atm. before the removal of the salts and about 20 atm. after removal of the salts (interpolation of his curve 3). He draws the conclusion that the suction forces of these soils are caused, for the greater part, by "the capillary, adsorption and imbibition forces" and not by the salts present. This conclusion is valid for all Non-saline Hammadas, where the high suction forces are nearly always caused by their mechanical composition and not by their salt content. This does not mean that the salt content is completely unimportant. The salt content is low only in comparison with the Salt Hammadas, but quite high when compared with normal agricultural soil. We fully endorse Harder's statement (8, p. 696) that these salts become an important factor for vegetation because "with the small water content (of the soil) the suction forces of the salts combine themselves with the suction forces caused by the structure of the soils."

We can thus understand plant distribution in Non-saline Hammadas.

As the combination of low salt content and fine soil particles results in suction forces lower than those of Salt Hammadas (at a water content of  $3\frac{1}{2}\%$  the suction forces vary between 20 and 170 atm. in different localities), some plants, like *Anabasis articulata*, can still grow even on the flat, salt-containing parts of this type of Hammada. Where the salts are leached out, the suction forces are only slightly lowered, but even this slight reduction makes possible a much better plant growth. This is the reason why even in Non-saline Hammadas plant life is richest in the rain gulleys and small wadies.

In connection with the problem of high suction forces, one other type of desert soil must be mentioned here, although it is not a Hammada soil, i.e., the dry clay lakes. Whereas in Salt Hammadas the main factor causing high suction forces lies in their high salt content, and the main factor in Non-saline Hammadas is their special mechanical make-up, the soil of dry clay lakes shows tremendously high suction force, because in this case a very high salt content is combined with a mechanical structure composed mainly of fine silt and clay, which is responsible for strong capillary, adsorption and imbibition forces. Therefore, no trace of plant life is present on these soils and even the lichens met with on the most extreme Salt Hammadas are completely absent.

These dry clay lakes are found in the deserts of Transjordan, southern Palestine and Sinai wherever a drainless basin is situated between desert hills. Rain water transports the finest clay particles, together with salts leached out from the surrounding hills, into these basins. When dry, they present a most peculiar sight. Their surface is absolutely smooth and mirrorlike. It is so smooth that when we tried to apply the brakes, while traversing such a dry clay lake, the car skidded as if on ice.

*Grit Hammadas*.—Neither the salt content nor the mechanical structure of these Hammadas can offer an explanation for the nearly complete lack of vegetation. The salt content is certainly not high enough to prevent the growth of such plants as are found in depressions of Salt Hammadas.

As shown in Table 2, *Haloxylon articulatum* grows on spots whose total salt content reaches 0.91%. In the Judean Desert (2-6) we found *Zygophyllum dumosum* on soils containing up to 1.66% of total salts. Montasir (14) reports *Launea*, *Fagonia*, etc. from Arabian desert soils in Wadi Hoff with a salt content of 1.01%, and *Pennisetum* and *Pithuranthus* from soils containing 1.11%, etc.

As these soils are composed of very coarse particles mixed with some coarse sand, the part of their suction force based on their mechanical structure equals nil. This condition is evident from the fact that their suction forces are actually much lower than those of Non-saline Hammadas. Therefore, the barrenness of the Grit Hammadas cannot be explained in terms of their suction forces. The correct explanation is seen in the fact

that the few plants growing in a Grit Hammada are invariably found where real soil has accumulated.

The materials which make up Grit Hammadas do not constitute soil in the biological sense. For they neither contain the elements necessary for plant growth, nor do they possess any water-retaining power, owing to their peculiar mechanical structure.

*Sand Hammadas.*—The presence of a relatively rich vegetation in Sand Hammadas can be explained as follows: (1) the sand covering these Hammadas does not contain salts, or only a very low percentage (0.01% and less), and (2) the sand cover is effective in keeping the water in the underlying Hammada soil.

#### THE NITROGEN CONTENT OF HAMMADA SOILS

From the time we made our first analysis of desert soil twelve years ago we have known that all desert soils are very poor in total nitrogen (determined after the method of Kjeldahl). Of the desert soils, Hammadas show the lowest N content. They contain on an average 0.014% nitrogen or 14 mg. per 100 g. of soil (Tables 1 and 2). The quantities found by Killian and Féher (12) in similar localities in North Africa are parallel. The average for regs is 11.6 mg./100 g. of soil (12, p. 31). We fully agree with their statement: “. . . dans les sols désertiques le taux de l'Az est nettement en dessous de la moyenne” (12, p. 86). This low nitrogen content is the more striking, as the soils of the Algerian littoral contain 100 mg./100 g., the Palestinian terra rossa about 200 mg./100 g. and the poorest agricultural soil in Palestine contains about 50–60 mg./100 g.

This low nitrogen content apparently is in no way connected with plant distribution in Hammadas, as the plant-bearing spots are only slightly richer in N than the barren parts. But there are indications that the low N content, as well as the low content in other nutrient salts, is responsible for the absence of plants other than those mentioned above from Hammadas and extreme desert soils in general. In other words, desert plants must be adapted not only to very poor water conditions and high soil and air temperatures, but also to a very low N content and deficiency in other nutrient elements. Additional proof is found in the fact that typical desert vegetation penetrates the Mediterranean part of Palestine wherever the soil is poor in nitrogen. These soils are covered by a typical desert vegetation (the best examples are the Kurkar hills), despite the fact that their water relations are much better than those found in any real desert soil. As our investigations (to be published shortly) have shown, their low N content and deficiency in other nutrients are the main factors responsible for the penetration of desert vegetation into a non-desert region and non-desert climate.

There is another interesting aspect of this deficiency of nitrogen in desert

soils. As pointed out by some authors (Mothes 16), plants grown in soils deficient in N or nutrient solutions develop typical xeromorphic structure. We cannot discuss this question here, but N deficiency in desert soils may be one of the causes of the well-known xeromorphic structure of desert plants.

We were unable to carry out a microbiological analysis and to determine the amount of nitrates in our soils. We cannot, therefore, state whether the interesting observations of Killian (10) and Killian and Féher (12) can be applied to our soils. These authors found active microorganisms even in the driest desert soils and reported a relatively high nitrate content in these soils.

#### SUMMARY

(1) Hammadas are slightly rolling desert plains covered with shiny black stone fragments and pebbles. Types described: Salt Hammadas, Non-saline Hammadas, Grit Hammadas and Sand Hammadas.

(2) Salt Hammadas: Their soil contains a high percentage of water soluble salts (0.968–3.98%) and a high percentage of sodium chloride (0.436–1.940%). These salts are responsible for the high suction forces developed by these soils. Plants can grow in these soils only after the salts have partly been leached out by rain water, i.e., in rain gulleys and slight depressions. Salt Hammadas are common in Middle Eastern and Egyptian deserts. The dominant plants are *Haloxylon articulatum* and *Zygophyllum dumosum*.

(3) Non-saline Hammadas: Their salt content is considerably lower than that of the Salt Hammadas. Their high suction force is caused by the fact that the percentage of silt and clay is much higher than in Salt Hammadas, causing high capillary, adsorption and imbibition forces. They are common in North Africa. The dominant plant in the Middle East is *Anabasis articulata*.

(4) Grit Hammadas: They are composed of coarse gypsum-carbonate grit. Their water soluble salt content, and especially chloride content, are lower than those of Salt Hammadas. They bear plants only where bits of soil or sand accumulate. The reason for their barrenness lies in the complete absence of real soil. They are found in the Sinai desert. The dominant plants are *Haloxylon salicornicum* in western Sinai and *Anabasis articulata* in northern and northeastern Sinai.

(5) Sand Hammadas: These are Hammadas secondarily covered by sand. As this sand is nearly salt-free and keeps the underlying layers wet, they bear a comparatively rich flora which is partly composed of psammophytes.

(6) Attention is drawn to the fact that Hammada soils are very poor in total nitrogen, a fact which is possibly related to the xeromorphic structure of most plants growing on Hammadas.

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## Orthrosanthus chimboracensis and Its Varieties (Iridaceae)

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One of the characteristic plants of the highlands of Guatemala and of the paramos in the Andes from Venezuela to central Peru is *Orthrosanthus chimboracensis*. It is a showy plant with its basal cluster of numerous slender iridiform leaves from which arise one or more flowering stems bearing elongate inflorescences with handsome clusters of bluish flowers.

Although having a wide distribution from northern Mexico south through Central America to the Andes of Central Peru, it has generally been treated as a single species. Not until recently, when Foster<sup>1</sup> segregated the variety *exsertus*, has any segregation of the species been attempted. Having had an opportunity of observing and collecting this species in several parts of its natural range, in Guatemala where it is very common, and in Venezuela and Ecuador, the writer became impressed with the various differences in aspect in the field manifested by the plants of Guatemala and by those of South America. Subsequent study has revealed that these apparent differences are actual ones, as an examination of the large amount of material preserved in the Herbarium of the Chicago Natural History Museum and of that in the United States National Herbarium brings out. Differences exist not only in habit but also in such characters as size and pubescence of capsules, size of seeds, size of spathes, relative length of pedicels, and arrangement of flower clusters in the inflorescence.

*Orthrosanthus chimboracensis* was described by Humboldt and Bonpland<sup>2</sup> as *Moraea chimboracensis* in 1815, and based upon material collected by them on the slopes of Chimborazo volcano "inter Calpi et rupem Yana-Urcu",<sup>3</sup> which is situated to the northeast of the present town of Guaranda in the province of Bolivar, Ecuador. The variability of this group in South America was evidently apparent to these authors, since they described as distinct no less than three species, i.e., *Moraea chimboracensis*, *M. gladioloides*, and *M. acorifolia*, based on three separate collections made respectively in Ecuador, Peru, and Venezuela. These entities were later transferred by Baker<sup>4</sup> to the genus *Orthrosanthus* and all placed with the inclusive species *O. chimboracensis*. A detailed study of the material at hand reveals that at least one of the species of Humboldt and Bonpland, i.e., *Moraea acorifolia*, from the coastal mountains of Venezuela, appears to be a valid variety of *Orthrosanthus chimboracensis*, while two new varieties, from southern Mexico and Central America, are described in the present paper. Besides the typical variety based upon the plant collected at the

<sup>1</sup> Foster, Robert C. Contr. Gray Herb. 155: 49. 1945.

<sup>2</sup> Humboldt, A., Bonpland, A. and C. Kunth. Nov. Gen. & Sp. 1: 322. 1815.

<sup>3</sup> Loc. cit.

<sup>4</sup> Baker, J. G. Gard. Chron. N. Ser. 6: 67. 1876.

type locality in Ecuador, and the recently described var. *exsertus* Foster from Mexico, three other varieties are described herewith. Material from the Herbarium of the Chicago Natural History Museum is cited as (F), while that from the United States National Herbarium is cited as (US). The author wishes to thank Mr. E. P. Killip, Curator of the Herbarium, Division of Plants, of the United States National Museum, for lending the material from that institution.

## KEY TO THE VARIETIES OF ORTHROSANTHUS CHIMBORACENSIS

- A. Flowers white
  - A. Pedicels 15–25 mm. long. . . . . *O. chimboracensis* var. *exsertus* f. *albus*
  - A. Pedicels at most 5 mm. long. . . . . *O. chimboracensis* var. *acorifolius* f. *albus*
- A. Flowers blue to purplish
  - B. Capsule strongly exserted, long-stipitate; pedicels 15–25 mm. long, some of them, even in anthesis, exserted beyond the spathe, in fruit all of them exserted; Mexican . . . . . *O. chimboracensis* var. *exsertus*
  - B. Capsule sessile or very short-stipitate; pedicels at most 5 mm. long, not exserted beyond the spathe
    - C. Ovary and fruiting capsule glabrous; capsule mostly 16–25 mm. long; seeds 1.5–2.0 mm. long. . . . . *O. chimboracensis* var. *typicus*
    - C. Ovary and fruiting capsule more or less pubescent, sometimes appearing only sparsely so or even glabrate; capsule mostly 8–16 mm. long; seeds 1–1.5 mm. long
      - D. Flowers, especially the upper, in dense fascicles, remotely separated from one another, the uppermost sessile; spathes immediately subtending flowers 8–13 mm. long; rachis of peduncle relatively slender; leaves slender, short, 2–8.5 (rarely to 10) mm. wide; plants of Mexico south to Costa Rica. . . . . *O. chimboracensis* var. *centro-americanus*
      - D. Flowers usually more regularly scattered along the rachis, usually one or more of the flowers in a cluster pedunculate, the clusters not remotely separated; spathes immediately subtending flowers 12–20 mm. long; rachis of peduncle relatively stout; leaves more elongated, 4–16 mm. wide; plants of South America north to Costa Rica
        - E. Mature capsule 8–11 mm. long; seeds 1–1.2 mm. long; plants of Venezuela and Colombia. . . . . *O. chimboracensis* var. *acorifolius*
        - E. Mature capsule 12–16 mm. long; seeds 1.5 mm. long; plants of Costa Rica and Panama. . . . . *O. chimboracensis* var. *intermedius*

***Orthrosanthus chimboracensis* (H.B.K.) J. G. Baker, var. *typicus*.**

*O. chimboracensis* (H.B.K.) J. G. Baker, Gard. Chron. N. Ser. 6: 67. 1876; *Morea chimboracensis* H.B.K. Nov. Gen. & Sp. 1: 322. 1815; *Moraea gladioloides* H.B.K. loc. cit. 1815; *Sisyrinchium Moritzianum* Klotzsch ex Klatt in Linnaea 31: 378. 1862.

Mostly stout perennial tufted herb with short coarse rhizome, 2–11.5 dm. tall; leaves numerous, distichous, equitant, narrowly ensiform, gradually acuminate, mostly basal, except for the foliose flowering stems, firmly membranaceous, finely and numerously ribbed, the thickened margins densely scabridulous-puberulent, 15–70 cm. long, 0.3–1.0 cm. wide; stems one to several, conspicuously foliose below, sparsely foliose and reduced above, terete, mostly stout, 3.5–8 mm. in diameter, glabrous, simple or branched above in the inflorescence; inflorescence erect, racemose-paniculate, mostly narrowly elongate, 6–35 cm. long, the flower clusters peduncu-

late, mostly 2-, sometimes 3-flowered, each cluster subtended by a spathiform bract or reduced cauline leaf which mostly exceeds the flowers; middle and upper bracts narrowly to broadly lanceolate, acute to acuminate, margins scarious, mostly 2–8 cm. long, the lower longer and more foliaceous; spathes subequal, ovate-lanceolate, caudate-acuminate, finely ribbed, membranaceous, margins broadly scarious, 1.3–2 cm. long; flowers blue to purplish, about 3 cm. in diameter, rotate, perianth tube very short, perianth segments 1.3–1.6 cm. long; ovary glabrous; capsule sessile to slightly pedicellate, narrowly oblong-elliptic, glabrous, 16–25 mm. long.—Paramos and transition zone between dwarf forest and subparamo at elevations of 2,500–3,800 meters in the Andes of Peru, Ecuador, Colombia, and western Venezuela, and locally north in Costa Rica at elevations between 2,000–3,000 meters.

Specimens examined: COSTA RICA: CARTAGO: Volcán de Turrialba, Jan., 1899, *Pittier 7515* (US); southern slope of Volcán de Turrialba, near Finca del Volcán de Turrialba, *Standley 34959* (US); SAN JOSÉ: Cerro de las Vueltas, *Standley & Valerio 44000* (US). VENEZUELA: TACHIRA: paramo near Bailadores, *Archer 3151* (US); MERIDA: Quebrada de Saisy, *Gehriger 39* (F, US); on the Paramo, *Reed 71* (US). COLOMBIA: SANTANDER: edge of Páramo de las Vegas, *Killip & Smith 15721* (US); vicinity of La Baja, *Killip & Smith 17170* (US); edge of Páramo de Santurbán, near Vetás, *Killip & Smith 17584* and *17936* (US); edge of woods between California and Vetás, *Killip & Smith 17993* (US); BOYACA: between Soatá and Cocuy, Páramo del Alto del Escobal, *Cuatrecasas 1234* (US); woods on south slope, Nevado del Cocuy, Chorrón de San Paulino, *Cuatrecasas 1357* (US); CUNDINAMARCA: Guadalupe, Bogotá, *Bro. A pollinaire & Bro. Arthur 119* (US); Sabana de Bogotá, *Arbelaez 171* (US); Guadalupe, Bogotá, *Bro. Ariste-Joseph A 60* (US); Macizo de Bogotá, Quebrada de San Cristobal, *Cuatrecasas 5125* (US); Quebrada de Chicó, *Cuatrecasas 5372* (US); páramo, Alto de las Cruces-Guadalupe, *Cuatrecasas 5552* (US); Cordillera Oriental, Páramo de Zipaquirá, entre Zipaquirá y Pacho, *Cuatrecasas 9522* (US); subpáramo belt, Guasca, *Verne Grant 7379* (US); Bogotá Plateau, Monserrati, *Niemeyer 146* (US); CAUCA: Las Escalereatas, Moras Valley, Río Paez basin, Tierra Adentro, *Pittier 1340* (US); WITHOUT LOCALITY: Andes Grana-denses, *Triana 260* (US). ECUADOR: CARCHI: wooded hills about 5 miles south of Tulcán, *A. S. Hitchcock 20988* (US); PICHINCHA: declive oriental del Volcán Pichincha, near summit of Cruz Loma, 5–6 km. west of Quito, *Steyermark 52414* (F); pajonal, Huairapungo, *Firmin 637* (F, US); BOLIVAR: Hacienda Talahua, *Penland & Summers 580* (F); CHIMBORAZO: open places in woods of Cordillera Oriental, *Rimbach 115* (US); forest region, Cordillera Oriental, *Rimbach 523* (F); CAÑAR: vicinity of Santa Rosa de Cañar, *J. N. and George Rose 22663* (US); AZUAY: Nabon, *J. N. and George Rose 23911* (US); WITHOUT LOCALITY: Pilacutim, *Rorud* (F). PERU: HUANCVELICA: Tayacaja, Montepungo, 5 km. east of Surcubamba, *Stork & Horton 10378* (F); HUANUCO: Mito, *Macbride & Featherstone 1659* (F).

The var. *typicus*, together with var. *exsertus* of Mexico, differs from the other varieties of the species, principally by the glabrous and relatively long capsules. The more or less pedunculate branches of the inflorescence with the flowers more or less regularly scattered throughout and the relatively large spathes are characters shared by the varieties *acorifolius* and *intermedius* as well, but contrasts strikingly with the Central American var. *centro-americanus* with its smaller spathes and flowers in dense sessile fascicles.

**O. chimboracensis** var. **exsertus** Foster, Contr. Gray Herb. 155: 49. 1945.

Slender tufted perennial, 3–6.5 dm. tall; leaves 25–60 cm. long, 0.5–0.8 cm. wide; stems foliose below, mostly slender, 3–4 mm. in diameter, mostly simple or only slightly branched above; inflorescence racemose-paniculate, mostly narrowly elongate as in the typical variety, 15–35 cm. long; flower clusters mostly long pedunculate, sparsely and mostly 1–2-, sometimes 3-flowered; lowest peduncle  $1/3$  or less the height of inflorescence; middle and upper bracts subtending the flower narrowly lanceolate, acuminate, 3–5 cm. long, the lower more foliose and up to 13 cm. long; spathes 1.2–1.7 cm. long; flowers mostly blue, about 2.5–3 cm. in diameter; perianth segments 1.2–1.5 cm. long; ovary glabrous, pedicellate; capsule glabrous, 15–25 mm. long, conspicuously stipitate, on pedicels 15–25 mm. long, elliptic-oblong, conspicuously tapering at base; seeds 1.5–2 mm. long, dark brown, finely rugulose.—Mountains of Mexico, at elevations between 1,500 and 3,300 meters.

Specimens examined: MEXICO: TAMAULIPAS: without definite locality, *Runyon & Thorp* 4063 (US); SAN LUIS POTOSI: Ahuacatlan al Oregano, Jilitla, *Maury* 6849 (F, US); FEDERAL DISTRICT: shaded banks near Eslaba, *Pringle* 11707 (F, US); sides of ravines near Eslaba, *Pringle* 8827 (F, US); Ixtaccihuatl, *Purpus* (US); MEXICO: District of Temascaltepec, pine woods, Comunidad, *Hinton* 3503 (F, US); HIDALGO: Zacualtipam, *Maury* 5860 (F, US); PUEBLA: river banks below Honey Station, *Pringle* 13219 (US); Chinantla, *Liebmann* 14598 (F).

This variety, because of its conspicuously exserted long-pedicellate ovaries and capsules, stands further removed from the other varieties with which it is placed than they are from one another. It apparently is limited to Mexico. Collections made by W. E. Nelson (546, 703a, 704) and deposited in the United States National Herbarium are atypical; the capsules in number 546, from the west slope of Mt. Zempoaltepec, Oaxaca, have much shorter capsules than is characteristic of this species.

**O. chimboracensis** var. **exsertus** forma **albus** f. nov.—A typo recedit periantho albo.

TYPE collected in MEXICO: TAMAULIPAS: Santa Rita, Ranch Tamaulipas, alt. 1,500 meters, April 8, 1926, *Runyon* 875 (US). Known only from the type collection.

**O. chimboracensis** var. **centro-americanus** var. nov.—A typo recedit foliis tenuioribus brevioribusque 2–10 mm. latis; caulibus supra parce foliosis tenuioribus; floribus plerumque dense fasciculatis sessilibusque; bracteis reductis brevioribusque quam var. typicus; spathis 8–13 mm. longis; ovario pubescente; capsulis pubescentibus 8–16 mm. longis; seminibus 1–1.5 mm. longis.

Small to medium-sized tufted herb, 1.5–6 dm. tall; leaves averaging narrower and shorter than in the typical variety, 10–60 cm. long, 0.25–1.0 cm. wide; stems sparsely or not at all foliose above, more slender than in

the typical variety, 1.5–4 mm. in diameter, simple or slightly branched above in the inflorescence; inflorescence paniculately branched, broader than in the other varieties, mostly exceeding the leaves, 5–25 cm. long; upper and middle flower clusters in dense sessile fascicles, mostly 3–6 in a fascicle, the lower usually long pedunculate, lowest peduncle  $\frac{1}{3}$ – $\frac{1}{2}$  the height of inflorescence; middle and upper bracts much reduced, shorter than in the typical variety, mostly 1.5–4 cm. long, the lowest bracts more foliose, 4–9 cm. long; spathes 0.8–1.3 cm. long; flowers blue, 2.4–3 cm. in diameter; perianth segments about 1.2–1.5 cm. long; ovary pubescent; capsule sessile to slightly pedicellate, pubescent, oblong-clavate, obtuse to subtruncate at apex, less attenuate than in the typical variety, 8–16 mm. long; seeds 1–1.5 mm. long, mostly rufous brown to castaneous.—Brushy or open rocky slopes, often in oak, pine, or fir forests, southern Mexico to Guatemala and Salvador, and locally south in Costa Rica, at elevations of 1,500–3,000 meters.

Specimens examined: MEXICO: OAXACA: Sierra de San Felipe, *Pringle 4683* (US); CHIAPAS: Cerro del Boqueron, *Purpus 6968* (US); Gebirge zwischen Oxchuc und San Martín, *Caec. & Ed. Seler 2253* (US). GUATEMALA: HUEHUETENANGO: brushy banks about Laguna de Ocubilá, east of Huehuetenango, *Standley 82640* (F); mountains southwest of Malacatancito, *Standley 62637* (F); SAN MARCOS: slopes of barrancos tributary to and bordering Río Vega, between San Rafael at northeast portion of Volcán Tacaná and Guatemala-Mexico line, *Steyermark 36290* (F); open steep slopes along barranco of Río (Tonaná) Suchiaté, between Canjulá and La Unión Juárez, near southeast portion of Volcán Tacaná, *Steyermark 36439* (F); barrancos south and west of town of Tajumulco, northwestern slopes of Volcán Tajumulco, *Steyermark 36583* (F); upper south-facing forested slopes of Volcán Tajumulco, between Las Canoas and top of ridge, 7 mi. from San Sebastian, *Steyermark 35799* (F); QUICHÉ: without definite locality, *Aguilar 1130* (F); between Quiché and San Pedro on dry rolling hills with pine and oak forest, Jocopilas, *Standley 62470* (F); forested barranco south of Chichicastenango, *Standley 62419* (F); Chiniqué, *Heyde & Lux 3530* (US); QUEZALTENANGO: in damp dense mixed forest on white sand slopes above Mujulá, between San Martín Chile Verde and Colomba, *Standley 85533* (F); in Cupressus forest, mountains above Ostuncalco, *Standley 66381* (F); Aguas Calientes zwischen Gebüsch und feuchten Hängen, *Caec. & Ed. Seler 2886* (US); TOTONICAPÁN: along road between San Francisco El Alto and Mostostenango, *Standley 84069* (F); near Cumbre del Aire, on road between Huehuetenango and Sija, *Standley 65852* (F); SOLOLÁ: Volcán Santa Clara, north-facing slopes towards Lago de Atitlán, *Steyermark 47092* (F); SUCHITEPEQUEZ: on ridge, beneath open woods, south slope, Volcán Atitlán, *Skutch 1514* (F); CHIMALTENANGO: wet brushy bank, Cerro de Tecpám, region of Santa Elena, *Standley 61040* (F); Tecpam, *Johnston 763* (F); Tecpam, *Johnston 652* (F); pine and oak forest, Barranco de la Sierra, southeast of Patzún, *Standley 61562* (F); Chichavac, *Skutch 396* (US); Chichavac, *Salas 585* (US); SACATEPÉQUEZ: damp forest, slopes of Volcán de Agua, above Santa María de Jesús, *Standley 65180* (F); Embaulada, *Heyde & Lux 4639* (US); GUATEMALA: without definite locality, *Aguilar 319* (F); San Rafael, *Mrs. B. B. Lewis 291* (F); JALAPA: pine-oak woods near top, between Miramundo and summit of Montaña Miramundo, between Jalapa and Mataquescuintla, 6 mi. south of Miramundo, *Steyermark 32762* (F); JUTIAPA: exposed rocky slopes on summit, Volcán Suchitán, northwest of Asunción Mita, *Steyermark 31913* (F, TYPE); ZACAPA: pine-covered canyon bordering Río Lima, Sierra de las Minas, below Finca Alejandria, *Steyermark 30044* (F); slopes of Monte Virgen, around summit of mountain, Sierra de las Minas, *Steyermark 42636* (F). SALVADOR: SANTA ANA: Volcán de Santa Ana, *Carlson 686* (F, US). COSTA RICA: ALAJUELA: Volcán Poas, *J. D. Smith 6835* (US); SAN JOSÉ: potrero, Laguna de la Chonta, northeast of Santa María de Dota, *Standley 42219* (US); oak forest near Quebradillas, about 7 km. north of Santa María de Dota, *Standley 42879* (US); Cerro de Escasú, *Solis 252* (F); Piedra Blanca Escasú, *Solis 161* (F).

This variety appears well-marked by its small pubescent capsules, relatively small spathes, and dense fascicles of sessile flowers, the lowest prominently pedunculate and unbranched. The leaves average shorter and narrower than in typical *O. chimboracensis*, while the flowering stems in general are shorter.

***O. chimboracensis* var. *acorifolius* (H.B.K.) n. comb.**

*Moraea acorifolia* H.B.K. Nov. Gen. & Sp. 1: 322-323. 1815.

Descr. emend.—A typo recedit ovario capsulisque pubescentibus; capsulis maturis 8-11 mm. longis; seminibus 1-1.2 mm. longis.

Mostly stout perennial, 4-6 dm. tall; leaves 15-62 cm. long. 0.6-1.5 cm. wide; stems stout, similar to those in the typical variety; inflorescence paniculate, the lower axes usually branched, rather regularly flowered throughout, 13-30 cm. long; flower clusters mostly pedunculate; middle and upper bracts subtending the flower clusters similar to the typical variety, the lower conspicuously foliose and elongated; spathes 12-20 mm. long; flowers blue; ovary pubescent; capsule sessile to slightly pedicellate, 8-11 mm. long; seeds 1-1.2 mm. long.—Coast Range and Andes of Venezuela to Andes of Colombia, at elevations mainly between 2,000-3,200 meters.

Specimens examined: VENEZUELA: MERIDA: Páramo Agua de Obispo, *Jahn* 1183 (US); Páramo del Molino, *Jahn* 932 (US); TRUJILLO: La Quebrada Cortijo, on ridge shoulder, by boundary line Lara-Trujillo, above Humocaro Bajo, *Steyermark* 55339 (F); DISTRITO FEDERAL: Silla de Caracas, *Pittier* 8371 (US); MONAGAS: Cerro Negro, above La Sabana de las Piedras, northwest of Caripe, *Steyermark* 62065 (F); ANZOATEGUI: among shrubby dwarfed growth along knife-edge crest of ridge leading to summit, Cerro Peonía (Cerro Los Pajaritos), above Santa Cruz, headwaters of Río Manantiales, east of Bergantín, *Steyermark* 61655 (F); SUCRE: north-facing steep sandstone slopes, from beginning of sandstone to summit of cerro, Cerro Turumquire, *Steyermark* 62600 (F).

Although merged by Baker and later authors with typical *O. chimboracensis*, this variety may be distinguished by its smaller pubescent capsules and smaller seeds.

***O. chimboracensis* var. *acorifolius* f. *albus* f. nov.**—A typo differt corolla alba.—Andes of Venezuela at an elevation of 2,600-2,800 meters.

VENEZUELA: TRUJILLO: La Quebrada Cortijo, in dense woods below paramo and ridge top, by boundary line Lara-Trujillo, above Humocaro Bajo, *Steyermark* 55339a. (F, TYPE).

This white-flowered form was found on a single individual scattered among the normal blue-flowering specimens.

***O. chimboracensis* var. *intermedius* Steyermark, var. nov.**—A typo recedit ovario capsulisque pubescentibus; capsulis maturis 12-16 mm. longis; seminibus 1.5 mm. longis.

Mostly stout perennial, 3-9.5 dm. tall; leaves 25-60 cm. long, 0.3-1.2 cm. wide; stems mostly stout, similar to those in typical variety; inflorescence

paniculate, the lower axes mostly branched and elongated, usually more conspicuously so than in the typical variety, 12–25 cm. long; flower clusters mostly pedunculate; middle and upper bracts subtending the flower clusters similar to those of the typical variety, the lowest conspicuously foliose and elongated; spathes 1.3–1.7 cm. long; flowers blue; ovary pubescent; capsule sessile to slightly pedicellate, pubescent, 12–16 mm. long; seeds 1.5 mm. long.—Upper slopes of volcanoes of Costa Rica and Panama, at elevations from 1,600–3,700 meters.

Specimens examined: COSTA RICA: CARTAGO: Volcán Irazú, *Allen* 674 (F); Volcán Irazú, *Oersted* 14588 (F); Volcán Irazú, *Pittier* 11581 (US); Volcán Irazú, *Quiros* 337 (F); Volcán Irazú, *Rowlee & Stork* 879 (US); Volcán Irazú, *J. D. Smith* 4975 (US); above Finca of Arturo Volio, Irazú, *Stork* 2874 (F); Volcán de Turrialba, *Pittier* 7515 (US); ALAJUELA: Achioté, Poas, *Tonduz* 10772 (F, US); SAN JOSÉ: Cerro de Piedra Blanca, above Escasú, *Standley* 32567 (US); Los Frailes, *Valerio* 1369 (F). PANAMA: CHIRIQUI: Potrero Muleto, Volcán de Chiriqui, Boquete district, *Davidson* 1020 (F).

This variety approaches the South American *O. chimboracensis* var. *acorifolius* in its type of inflorescence, size of spathes, and pubescence of capsules, but differs in its slightly larger capsules and seeds. It is somewhat intermediate between *O. chimboracensis* var. *acorifolius* and var. *centro-americanus*, and is the least well-marked of the several varieties. It apparently is best developed in the mountains of Costa Rica and adjacent Panama.

## Florida Boletes

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Since the publication of my monographic work on American boletes the North Carolina species have been treated in a book by Coker and Beers; several of the northern species in various articles by W. H. Snell; and the Florida species by me in a mimeographed paper, followed recently by Rolf Singer's three important contributions, in *Farlowia* (2: 97-141 and 223-303. 1945) and the *American Midland Naturalist* (37: 1-135. 1947). A fourth paper in *Farlowia* (2: 527-567. 1946) contains nothing of special interest to the student of the Boletaceae, since it treats agaric genera like *Gomphidius*, *Paxillus* and *Clitopilus*.

Although not entirely in agreement with Dr. Singer as regards certain minor matters, I admire his enthusiasm and trust he will continue to obtain firsthand information of our numerous interesting species as the seasons come and go. Perhaps ten years from now we shall both see things somewhat differently.

The collapse of the American Code necessitated changes in the nomenclature of the boletes resulting in confusion and complications. Therefore I am considering here primarily the *species*, listing them for greater convenience in alphabetical order under Saccardo's genera (*Boletus*, *Boletinus* and *Strobilomyces*).

### BOLETACEAE

Hymenophore annual, usually terrestrial and centrally stipitate; context fleshy; hymenium poroid, fleshy or fleshy-tough, never gelatinous; spores usually elongate, variously colored.

The species listed below might mostly be grouped in the following genera: *Boletellus* Murr., *Boletus* Dill. ex Fr., *Frostiella* Murr., *Gyroporus* Quél., *Leccinum* S. F. Gray, *Porphyrellus* Gilbert, *Pulveroboletus* Murr., *Suillellus* Murr., *Suillus* Micheli ex S. F. Gray, *Tylopilus* Karst. and *Xerocomus* Quél.

### BOLETUS Auct.

*B. affinis* Pk. See N. Am. Fl. 9: 142. 1910.—Described from N. Y. and found in thin woods from Vt. to northern Fla. and westward to Ind. Frequent about Gainesville and also collected in Clay, Columbia and Marion Counties.

*B.alachuanus* Murr. Mycol. 30: 522 and 525. 1938.—Described from near Gainesville, in a hammock.

*B. albellus* Pk. See N. Am. Fl. 9: 138. 1910.—Described from N. Y. and

found in woods in temp. N. A., southward to northern Fla., where it is rare. Belongs in *Leccinum*.

*B. albellus reticulatus* Murr. Lloydia 9: 329 and 330. 1946.—Described from Gainesville, where it is rare. Belongs in *Leccinum*.

*B. albisulphureus* Murr. Lloydia 7: 325 and 326. 1944.—Described in *Gyroporus* from near Planera Hammock, northwest of Gainesville, in turkey-oak woods.

*B. alboater* Schw. See N. Am. Fl. 9: 135. 1910.—Described from N. C. and found in open frondose woods from N. Y. to northern Fla. and westward to Mo. Collected rarely in Alachua and Columbia Counties. Belongs in *Tylopilus*.

*B. ananas* M. A. Curt. See N. Am. Fl. 9: 156. 1910.—Described from S. C. and found from N. C. to central Fla., Ala. and Miss. near pines. Frequently collected in Alachua, Clay, Madison and Putnam Counties. Belongs in *Boletellus*.

*B. aureissimus* Murr. Mycol. 30: 522 and 525. 1938.—Described from Gainesville, under a laurel oak, and abundant in the vicinity. Singer thinks it is *B. auripes* Pk., but the types do not agree.

*B. austrinus* Sing. Mycol. 37: 798. 1945.—Described from near Miami, under oaks. Said to have reddish tube-mouths and a tomentose cap. Belongs in *Suillellus*. I have not seen it.

*B. bicolor* Pk. See N. Am. Fl. 9: 147. 1910.—Described from N. Y. and found in open woods from New Eng. to Fla. and westward to Ohio and Ky. Abundant under oaks at Gainesville. A large, attractive species entirely distinct from *B. rubritinctus* Murr. and *B. luridellus* Murr. Singer places it in the *rubellus* complex, along with some other species. Compare *B. rubellus bicoloroides* Sing.

*B. biporus* Murr. Lloydia 7: 325 and 326. 1944.—Described in *Gyroporus* from Gainesville, near laurel oak. Frequent.

*B. brasiliensis* Rick. See Sing. Farlowia 2: 298. 1945.—Described from Brazil and reported from Highlands Co., in frondose woods. Placed by Singer in *Xerocomus*. I have not seen it.

*B. brevipes* Pk. See N. Am. Fl. 9: 153. 1910.—Described from N. Y. and found under pines in many parts of the eastern U. S. Common about Gainesville in cool weather. Belongs in *Rostkovites*.

*B. castaneus* Bull. ex Fr. See N. Am. Fl. 9: 133. 1910.—Described from France and found in woods in temp. N. A., south to northern Fla., where it is frequent. Belongs in *Gyroporus*.

*B. castaneus* f. *purpurinus* Snell, Mycol. 28: 465. 1936.—Described from collections in N. Y. and Mich. Rare in woods about Gainesville and widely distributed in Florida. I regard it as a variety rather than a species.

*B. conicus* Rav. See N. Am. Fl. 9: 140. 1910.—Described from S. C. and also found rarely in Fla. in pine woods. Belongs in *Tylopilus*.

*B. cyaneitinctus* Murr. Lloydia 6: 225 and 228. 1943.—Described from a hammock near Gainesville. This species is very near *B. pulverulentus* Opat. (*B. mutabilis* Morg.), which I found in Gainesville in November, 1947.

*B. cyanescens* Bull. ex Fr. See N. Am. Fl. 9: 134. 1910.—Described from France and found in woods in eastern N. A., south to northern Fla., where it is very rare. Belongs in *Gyroporus*.

*B. deflexus* Murr. Bull. Torr. 67: 61 and 66. 1940.—Described from near Gainesville, in oak-pine woods. The specimens are rather young.

*B. edulis* Bull. ex Fr. See N. Am. Fl. 9: 142. 1910.—Described from France and widespread in temperate regions in several forms. Abundant about Gainesville under frondose trees. Singer calls our common Florida form *B. aereus* Bull. ex Fr., which Bresadola said was confined to Europe.

*B. felleus* Bull. ex Fr. See N. Am. Fl. 9: 134. 1910.—Described from France and abundant in woods in Eur. and temp. N. A., southward to central Fla. Rare about Gainesville. Belongs to *Tylopilus*.

*B. flavimarginatus* Murr. Mycol. 31: 110 and 112. 1939.—Described from Gainesville, under live-oak, and found frequently in the vicinity. Singer has discussed the species in two of his papers, but his remarks are not very convincing. See Mycol. 38: 113. 1946. My opinion has not changed.

*B. flavissimus* Murr. Mycol. 30: 522 and 525. 1938.—Described from Gainesville, under a water oak on a lawn, and frequent in the vicinity.

**Boletus floridanus** (Sing.) Murr., comb. nov. Described from Gainesville, under oaks, as a variety of *B. Frostii* Russell *apud* Frost. Also reported from Highlands Co. See Mycol. 37: 799. 1945 and Am. Mid. Nat. 37: 78. 1947. Belongs in *Suillellus*. I have had this prepared for publication as a species for some time.

*B. fraternus* Pk. See book by Coker and Beers, p. 60. 1943.—Distributed from New Eng. to central Fla., being common about Gainesville in and near frondose trees. There are related plants in Fla. which need further study. See Singer's treatment of this complex under *B. rubellus* Krombb. in Am. Mid. Nat. 37: 45. 1947.

*B. fumosiceps* Murr. Lloydia 6: 225 and 228. 1943.—Described in *Gyroporus* from Gainesville, under laurel oak. Very rare.

*B. fumosipes* Pk. See N. Am. Fl. 9: 149. 1910.—Described from N. Y. and found under oaks southward to northern Fla., where it is frequent. *B. sordidus* Frost is a doubtful synonym. Singer discards Peck's good name and substitutes *Porphyrellus pseudoscaber cyaneocinctus* Singer, which unnecessarily complicates matters. There is no doubt what Peck meant and the loss of an old, well-established name through a technicality would be unfortunate.

*B. granuloseiceps* Sing. Mycol. 37: 797. 1945.—Described from Miami, in a hammock. Unknown to me.

*B. griseus pini-caribaeae* Sing. Mycol. 37: 797. 1945.—Described from Coral Gables, under pines. Unknown to me.

*B. hemichrysus* B. & C. See N. Am. Fl. 9: 141. 1910.—Described from S. C. and found on pine from N. Y. to Fla. and Ala. Rare in Alachua, Clay and Putnam Counties. Singer considers this the same as *B. sulphureus* Fr., but I await further evidence.

**Boletus hemixanthus** (Sing.) Murr., comb. nov. See Farlowia 2: 292. 1945.—Described in *Xerocomus* from Alachua Co., Fla., at the bases of frondose trees in hammocks. Not studied by me.

*B. hirtellus* Pk. See N. Am. Fl. 9: 154. 1910.—Described from N. Y. and found under pines from Conn. and N. Y. to northern Fla., where it is rare. Collected in Alachua Co., in coniferous or mixed woods. Belongs in *Rostkovites*. Two subspecies are described by Singer, one from south Fla.

*B. hypocarycinus* Sing. Mycol. 37: 798. 1945.—Described from near Gainesville, under live-oak. I called it *B. luridus*, but did not study it carefully before sending it to Dr. Singer.

**Boletus hypoxanthus** (Sing.) Murr., comb. nov. See Farlowia 2: 289. 1945.—Described in *Xerocomus* from Highlands Co., on rotten wood or humus, and reported also from northern Fla. Unknown to me.

*B. inedulis* Murr. Mycol. 30: 523 and 525. 1938.—Described from Gainesville, under an evergreen oak, and rather common at times in the vicinity.

*B. isabellascens* Murr. Lloydia 9: 329 and 330. 1946.—Described from Gainesville, where it is abundant. Fresh spores decidedly pinkish (rosy-ocher). Distributed by me as *Tylopilus peralbidus*, which see. Not distinct from *T. praeanisatus* Murr.

*B. luridellus* Murr. Mycol. 30: 523 and 525. 1938.—Described from Gainesville, under an evergreen oak, and frequent in the vicinity. *B. subsensibilis* Murr. is not distinct.

*B. luridiceps* Murr. Lloydia 8: 289 and 290. 1945.—Described in *Suillellus* from Gainesville, under a laurel oak, and found rarely in the vicinity. Readily distinguished from *B. subvelutipes* Pk. by its glabrous stipe and slender spores.

**Boletus luteus** L. ex Fr. var. **cothurnatus** (Sing.) Murr., comb. nov. Described as a species from Fla., near pines, and found commonly in the northern and central parts of the state. Two subspecies are also described by Singer in Farlowia 2: 261. 1945.

**Boletus minor** (Sing.) Murr., comb. nov. See Mycol. 37: 799. 1945.—Described in *Tylopilus* from near Gainesville, in a hammock. Smaller than *T. felleus*. Unknown to me. Coker and Beers described a *B. felleus* var. *minor* from N. C.

*B. oliveisporus* Murr. Lloydia 7: 323 and 326. 1944.—Described from near Rochelle, Alachua Co., on stumps of slash pine. Rare in the vicinity.

*B. pallidiformis* Murr. Lloydia 7: 324 and 326. 1944.—Described from northwest of Gainesville, in dry oak-pine woods.

*B. pallidus* Frost. See N. Am. Fl. 9: 147. 1910.—Described from Vt. and found in woods from New Eng. to northern Fla. and Ala. Frequent about Gainesville and also collected in Columbia Co.

*B. parasiticus* Bull. ex Fr. See N. Am. Fl. 9: 141. 1910.—Described from France and found rarely in temp. N. A. on *Scleroderma*.

*B. peralbidus* Snell & Beards. Mycol. 28: 471. 1936.—Described from Altamonte Springs, Fla. Since our Gainesville plant is certainly not "all white," I have described it as *Tylopilus isabellenscens*. However, the type of *B. peralbidus* may have been young and the color undeveloped.

*B. pictiformis* Murr. Lloydia 6: 226 and 228. 1943.—Described in *Suillellus* from near Gainesville, in a hammock. Rare in the vicinity. Singer incorrectly places it in *Boletellus*. Pileus at first smooth but soon cracking as in *B. fraternus* Pk.

*B. pisciodorus* Murr. Mycol. 31: 111 and 112. 1939.—Described in *Gyroporus* from Gainesville, where it is common about frondose trees. Also collected in Putnam Co. Snell made it the type of his genus *Leucogyroporus*. Singer makes it a synonym of *B. tabacinus* Pk., but the types do not agree. See Mycol. 37: 794. 1945. The spores are pink in mass, but the print requires a long time.

*B. plumboviolaceus* Snell & Dick, Mycol. 38: 32. 1941.—Described from the eastern U. S. under oaks. Abundant about Gainesville. Belongs in *Tylopilus* next to *T. felleus*.

*B. praeanisatus* Murr. Lloydia 6: 225 and 228. 1943.—Described in *Gyroporus* from Gainesville, under laurel oak. Singer makes it a form of *T. peralbidus*. Color from isabelline to umbrinous.

*B. pseudoboletinus* Murr. Lloydia 7: 324 and 326. 1944.—Described from Gainesville in dry oak-pine woods. Also collected in Putnam Co. Singer places it in *Xerocomus* and reports it from Highlands Co.

*B. pseudogranulatus* Murr. Bull. Torr. 67: 63. 1940.—Described from Gainesville, under a loblolly pine. Singer makes it a variety of *B. brevipes* Pk. Belongs in *Suillus*.

*B. Ravenelii* B. & C. See N. Am. Fl. 9: 157. 1910.—Described from S. C. and found from New Eng. to the Gulf of Mexico. Collected in oak-pine woods in Alachua Co., and also found in Gilchrist Co. Belongs in *Pulveroboletus*.

*B. retipes* B. & C. See N. Am. Fl. 9: 146. 1910.—Described from N. C. and common in thin woods in eastern N. A. Rare about Gainesville; also collected in Clay Co. It does not belong in *Pulveroboletus*.

*B. Rhoadsiae* Murr. Torr. 67: 66. 1940.—Described from near Melrose,

Fla., and occasionally found in flatwoods in Alachua, Clay and Putnam Counties. Belongs in *Tylopilus*. Reported by Singer from Highlands Hammock.

*B. roseialbus* Murr. Mycol. **30**: 520 and 525. 1938.—Described in *Gyroporus* from Gainesville, under an oak. Common in the vicinity and also collected in Clay, Columbia and Putnam Counties. Singer says it is identical with *G. subalbellus* Murr., but the types do not agree. See Mycol. **38**: 114. 1946.

*B. rubricitrinus* Murr. Bull. Torr. **67**: 61 and 66. 1940.—Described from Gainesville, on a lawn near a laurel oak, and collected rarely by me in the vicinity. Singer says it apparently occurs all over Florida, both under pines and under oaks. He describes a variety from near Miami dedicated to Mr. Fairchild. I have not studied any of his material.

*B. Russellii* Frost. See N. Am. Fl. **9**: 137. 1910.—Described from New Eng. and found in open frondose woods westward to Wis. and southward to northern Fla., where it is rare. Belongs in *Frostiella*. Singer places it in *Boletellus*.

*B. scaber* Bull. ex Fr. See Coker & Beers 25. 1943.—Described from France and found in woods in temp. N. A., southward to northern Fla., where it is common under frondose trees. Very variable. Belongs in *Leccinum*. A tawny variety with firm, unchanging white flesh is common about Gainesville under laurel oak. Another variety with bluing flesh is less common and more variable. It was described by Singer in Mycol. **37**: 799. 1945 as a species, which in Saccardo's nomenclature would be **Boletus chalybaeus** (Sing.) Murr., but I prefer to consider it a variety. In Gray's genus this would be *Leccinum scabrum* (Bull. ex Fr.) S. F. Gray, var. **chalybaeum** (Sing.) Murr. It might be interesting to compare Bresadola's colored figure of *B. scaber* in his Icon. Mycol. **19**: pl. 936. 1931. A form of Singer's variety does not change to blue.

**B. scaber** Bull. ex Fr. var. **chalybaeus** (Sing.) Murr., comb. nov.—Described from near Gainesville, under oaks, and frequent in the vicinity under frondose trees. The color varies from pallid to dark-brown. See Mycol. **37**: 799. 1945 and Am. Mid. Nat. **37**: 121. 1947. Usually shows more blue than the typical form.

*B. sordidiformis* Murr. Lloydia **8**: 289 and 290. 1945.—Described from Gainesville, on a grassy lawn partly shaded by long-leaf pine and laurel oak.

*B. stramineus* Murr. Bull. Torr. **67**: 62 and 66. 1940.—Described in *Gyroporus* from Gainesville, in turkey-oak woods, and common in the vicinity in dry woods. Also reported from most of temp. Fla. Singer places it in *Xanthoconium*. *G. tenuisporus* Murr. and *G. Woodiae* Murr. are not distinct. It is often true that forms of a species described as distinct are found to overlap when better known through more observation and larger collections.

*B. subflavidus* Murr. Mycol. **30**: 521 and 525. 1938.—Described in *Tylopilus* from Gainesville, where it is frequent in oak woods. Also found as far south as Polk Co. Singer places it in *Porphyrellus*.

*B. subglabripes* Pk. See N. Am. Fl. **9**: 148. 1910.—Described from N. Y. and found in woods in eastern N. A. Rare about Gainesville under oaks. Placed in *Leccinum* by Singer. Intermediates are said to occur between this species and its variety.

*B. subglabripes* var. *corrugis* Pk. See Am. Mid. Nat. **37**: 115. 1947.—Found under frondose trees from N. Y. to N. C. Singer reports it from north Florida under the name *Leccinum rugosiceps* (Pk.) Sing.

*B. subluridus* Murr. Mycol. **30**: 524 and 525. 1938.—Described in *Suillellus* from Gainesville, under an evergreen oak, and collected several times in the vicinity. Singer makes it a variety of *B. miniato-olivaceus* Frost. See Mycologia for my criticism of his treatment.

*B. subsensibilis* Murr. Mycol. **31**: 111 and 112. 1939.—Described from Gainesville, under laurel oak, and common on shaded lawns in the vicinity. Singer reported it from Highlands Co. At first he made it a variety of *B. miniato-olivaceus* Frost, then a synonym of my *B. luridellus*, which is correct.

*B. subsolitarius* Sing. Mycol. **37**: 798. 1945.—Described from a tropical hammock near Miami. Unknown to me.

*B. subvelutipes* Pk. See Am. Mid. Nat. **37**: 68. 1947.—Described from N. Y. and found under frondose trees from New Eng. to central Fla. Belongs in *Suillellus* near *B. vermiculosus* Pk. and has often been determined as *B. luridus*.

*B. tenuisporus* Murr. Lloydia **6**: 225 and 228. 1943.—Described in *Gyroporus* from Camp O'Leno, Columbia Co., Fla., in open dry oak-pine woods. Not specifically distinct from *G. stramineus* Murr.

*B. umbriniceps* Murr. Lloydia **7**: 324 and 326. 1944.—Described from near Gainesville, on a rather dry bank under small laurel oaks.

*B. umbrinisquamowus* Murr. Bull. Torr. **66**: 33 and 37. 1939.—Described from Gainesville, in turkey-oak woods. Rare in the vicinity.

*B. Weberi* Sing. Mycol. **37**: 797. 1945.—Described from Gainesville, under longleaf pine. Belongs in *Suillellus*. Unknown to me.

*B. Woodiae* Murr. Lloydia **6**: 226 and 228. 1943.—Described in *Gyroporus* from a hammock near Gainesville. Not distinct from *G. stramineus* Murr.

#### BOLETINUS Auct.

Tubes large, shallow, radiating; spores smooth, yellow to brown; stipe central to lateral. My *Boletinellus* is separated by the absence of a veil.

*B. Berkeleyi* Murr. See. N. Am. Fl. **9**: 159. 1910.—Described from S. C. and found sparingly in thin woods from N. J. to Fla. and westward to Ky.

*B. floridanus* Murr. Lloydia 6: 224. 1943.—Described from near Melrose, Fla., under slash pine. Singer says this is *B. Berkeleyi*, but the large pores distinguish it.

*Boletus merulioides* (Schw.) Coker & Beers, var. *proximus* (Sing.) Murr., comb. nov.—Described as a species of *Gyrodon* from Gainesville, in moist frondose woods. Belongs in *Boletinellus*. Several years ago I distributed specimens under a varietal name which I had prepared for publication. For Singer's description see Farlowia 2: 244. 1945.

#### STROBILOMYCES Berk.

Pileus and stipe gray or blackish and shaggy; tubes angular, covered with a floccose veil; spores blackish-brown.

*S. confusus* Sing. Farlowia 2: 108. 1945.—Described from east of Gainesville, in flatwoods, and reported from Mass. to Ohio and southward to central Fla. Snell recognized this species many years ago.

*S. floccopus* (Vahl ex Fr.) Karst. See Farlowia 2: 110. 1945.—Described from Europe and found also in N. A., southward to Dade Co., Fla. It is generally known as *S. strobilaceus* Berk.

#### FLORIDA BOLETES KNOWN TO ME

<i>Boletellus ananas</i> (M. A. Curt.) Murr.	<i>Boletus hemichrysus</i> B. & C
<i>Boletinellus merulioides</i> (Schw.) Murr. var. <i>proximus</i> (Sing.) Murr.	<i>Boletus inedulis</i> Murr.
<i>Boletinus Berkeleyi</i> Murr.	<i>Boletus luridellus</i> Murr.
<i>Boletinus floridanus</i> Murr.	<i>Boletus oliveisporus</i> Murr.
<i>Boletus alachuanus</i> Murr. ( <i>Tylopilus</i> ?)	<i>Boletus pallidiformis</i> Murr.
<i>Boletus albisulphureus</i> Murr. ( <i>Gyroporus</i> )	<i>Boletus pallidus</i> Frost
<i>Boletus aureissimus</i> Murr.	<i>Boletus parasiticus</i> Bull. ex Fr.
<i>Boletus bicolor</i> Pk.	<i>Boletus retipes</i> B. & C
<i>Boletus biporus</i> Murr.	<i>Boletus rubricitrinus</i> Murr.
<i>Boletus cyaneitinctus</i> Murr.	<i>Boletus sordidiformis</i> Murr.
<i>Boletus deflexus</i> Murr.	<i>Boletus subglabripes</i> Pk.
<i>Boletus edulis</i> Bull. ex. Fr.	<i>Boletus subglabripes corrugis</i> Pk.
<i>Boletus flavimarginatus</i> Murr.	<i>Boletus umbriniceps</i> Murr.
<i>Boletus flavissimus</i> Murr.	<i>Frostiella Russellii</i> (Frost) Murr.
<i>Boletus fraternus</i> Pk.	<i>Gyroporus castaneus</i> (Bull. ex Fr.) Quél.
<i>Boletus fumosiceps</i> Murr. ( <i>Gyroporus</i> )	<i>Gyroporus castaneus</i> (Bull. ex Fr.) Quél. f. <i>purpurinus</i> Snell
	<i>Gyroporus cyanescens</i> (Bull. ex Fr.) Quél.
	<i>Gyroporus roseialbus</i> Murr.
	<i>Gyroporus umbrinisquamosus</i> Murr.

- Leccinum albellum* (Pk.) Sing.  
*Leccinum albellum* (Pk.) Sing. forma  
*reticulatum* (Murr.) Sing.  
*Leccinum scabrum* (Bull. ex Fr.)  
 S. F. Gray, tawny variety  
*Leccinum scabrum* (Bull. ex Fr.)  
 S. F. Gray, var. *chalybaeum*  
 (Sing.) Murr.  
*Porphyrellus fumosipes* (Pk.) Snell  
*Porphyrellus subflavidus* (Murr.)  
 Sing.  
*Pulveroboletus Ravenelii* (B. & C.)  
 Murr.  
**Rostkovites brevipes** (Pk.) Murr.,  
 comb. nov.  
*Rostkovites hirtellus* (Pk.) Murr.  
*Strobilomyces confusus* Sing.  
*Strobilomyces floccopus* (Vahl ex Fr.)  
 Karst.  
**Suillellus floridanus** (Sing.) Murr.,  
 comb. nov.  
*Suillellus luridiceps* Murr.  
*Suillellus pictiformis* Murr.  
*Suillellus subluridus* Murr.  
**Suillellus subvelutipes** (Pk.) Murr.,  
 comb. nov.  
*Suillus luteus* (L. ex Fr.) S. F. Gray,  
 var. *cothurnatus* (Sing.) Murr.  
**Suillus pseudogranulatus** (Murr.)  
 Murr., comb. nov.  
*Tylopilus alboater* (Schw.) Murr.  
*Tylopilus conicus* (Rav.) Beards.  
*Tylopilus felleus* (Bull. ex Fr.)  
 Karst.  
**Tylopilus pisciodorus** (Murr.)  
 Murr., comb. nov.  
*Tylopilus plumboviolaceus* Snell &  
 Dick.  
**Tylopilus praeanisatus** (Murr.)  
 Murr., comb. nov.  
*Tylopilus Rhoadsiai* (Murr.) Murr.  
*Xanthoconium affine* (Pk.) Sing.  
*Xanthoconium stramineum* (Murr.)  
 Sing.  
*Xerocomus hemixanthus* Sing.  
*Xerocomus pseudoboletinus* (Murr.)  
 Sing.

## FLORIDA BOLETES UNKNOWN TO ME

- Boletus granuloseps* Sing.  
*Boletus griseus pini-caribaeae* Sing.  
*Boletus peralbidus* Snell & Beards.  
 Compare *Tylopilus*.  
*Boletus rubellus* Kromb. Singer de-  
 scribes several subspecies  
*Boletus subsolitarius* Sing.  
**Suillellus austrinus** (Sing.) Murr.,  
 comb. nov.  
**Suillellus hypocarycinus** (Sing.)  
 Murr., comb. nov.  
**Suillellus Weberi** (Sing.) Murr.,  
 comb. nov.  
*Tylopilus minor* Sing.  
*Xerocomus brasiliensis* (Rick) Sing.  
*Xerocomus hypoxanthus* Sing.  
*Xerocomus illudens xanthomycelinus*  
 Sing. It is probably my *B. bi-*  
*porus*, which is not glabrous but  
 subtomentose.

## KEY TO THE LARGER GENERA

- Spores pallid or pale-yellow.....Gyroporus  
 Spores pinkish.....Tylopilus  
 Spores yellowish-brown.  
   Tube-mouths red.....Suillellus  
   Tube-mouths not red.....Boletus

## KEY TO GYROPORUS SPECIES

- Context white, changing to blue when wounded.....*G. cyanescens*  
 Context white, unchanging.  
   Pileus conspicuously squamulose.....*G. umbrinisquamosus*  
   Pileus not conspicuously squamulose.  
     Pileus and stipe brownish.....*G. castaneus*  
     Pileus and stipe rosy-white.....*G. roseialbus*

## KEY TO TYLOPILUS SPECIES

- Pileus black or brownish-black.....*T. alboater*  
 Pileus whitish.  
   Stipe reticulate.....*T. Rhoadsiae*  
   Stipe not reticulate.....*T. peralbidus*  
 Pileus yellow, brown or purplish.  
   Pileus 3-6 cm. broad.  
     Taste mild.....*T. conicus*  
     Taste bitter.....*T. minor*  
   Pileus reaching 10-15 cm. or more broad.  
     Pileus purplish.....*T. plumbviolaceus*  
     Pileus not purplish.  
       Stipe not reticulate.....*T. praeanisatus*  
       Stipe reticulate.  
         Taste usually mild, odor fishy.....*T. pisciodorus*  
         Taste bitter, odor none.....*T. felleus*

## KEY TO SUILLELLUS SPECIES

- Pileus and stipe red.  
   Context bluing when cut.....*S. floridanus*  
   Context unchanging.....*S. subluridus*  
 Pileus not red.  
   Pileus 4-6 cm. broad.....*S. pictiformis*  
   Pileus reaching 10-15 cm. broad.  
     Stipe glabrous.....*S. luridiceps*  
     Stipe with flocculose specks.....*S. subvelutipes*  
 Pileus brown, tomentose; Miami region.....*S. austrinus*  
 Gainesville region.  
   Context bluing when cut.....*S. hypocarycinus*  
   Context not bluing when cut.....*S. Weberi*

## KEY TO BOLETUS SPECIES

- Parasitic on *Scleroderma*.....*B. parasiticus*  
 On roots and stumps of pine; golden-yellow.....*B. hemichrysus*  
 On stumps of slash pine; bay-fulvous.....*B. olivisporus*  
 In soil; large, bright-yellow.....*B. flavissimus*  
 In soil; pores large, longer near stipe.....*B. biporus*  
 In soil; cap milk-white, tubes sulphur-yellow.....*B. albisulphureus*  
 In soil; cap chestnut, cyaneous when cut.....*B. cyaneitinctus*  
 In soil; tubes stuffed when young; variable.....*B. edulis*  
 Not as above.  
   Context not bluing when cut.  
     Stipe reticulate.  
       Pileus flavous.....*B. aureissimus*  
       Pileus reddish-fulvous.....*B. flavimarginatus*

Pileus dark-isabelline.....	<i>B. pallidiformis</i>
Pileus fumosous.....	<i>B. fumosiceps</i>
Pileus yellow to brown, bitter.....	<i>B. retipes</i>
Stipe not reticulate.	
Pileus avellaneous.....	<i>B. sordidiformis</i>
Pileus dark-avellaneous to umbrinous.....	<i>B. deflexus</i>
Pileus bay-fulvous.....	<i>B. alachuanus</i>
Pileus brown.....	<i>B. subsolarius</i>
Pileus brownish, stipe scurfy.....	<i>B. subglabripes</i>
Context bluing when cut.	
Stipe reticulate.	
Pileus red.....	<i>B. rubricitrinus</i>
Pileus brown.....	<i>B. granuloseps</i>
Pileus yellowish-brown.....	<i>B. luridellus</i>
Pileus isabelline, bitter.....	<i>B. inedulis</i>
Stipe not reticulate.	
Pileus pallid.....	<i>B. pallidus</i>
Pileus umbrinous.....	<i>B. umbriniceps</i>
Pileus red, about 5 cm.....	<i>B. fraternus</i>
Pileus red, about 10 cm.....	<i>B. bicolor</i>

## ABUNDANCE OF GAINESVILLE BOLETES

Based on my own collections within the city limits in the summer of 1947. Because of drought and cold there had been no real collecting season since the summer of 1946. In May, 1947, there was rain enough to start mycelial growth and on June 15 the daily summer rains began, continuing until the first week in July.

There was a spell of dry weather that stopped mushroom development until late in August. The second good collecting season began on August 22 and continued through August 30. A list of boletes collected in Gainesville during that period follows the first list. Saccardo's genera are used in both lists, with the latest specific names. Nine out of ten collections were made under laurel oak. There were over 1,000 collections.

June 21—July 6

## BOLETUS Auct.

*B. affinis* Pk. Frequent.  
*B. ananas* M. A. Curt. One good collection.  
*B. aureissimus* Murr. Frequent.  
*B. bicolor* Pk. Common.  
*B. biporus* Murr. Three ample collections. Rare before.  
*B. brevipes* Pk. One small hymenophore; a hang-over.  
*B. edulis* Bull. ex. Fr. Abundant.  
*B. flavimarginatus* Murr. Common.  
*B. flavissimus* Murr. Rare.  
*B. floridanus* (Sing.) Murr. The first of the Luridi to appear and unusually abundant this season.  
*B. fraternus* Pk. Frequent.  
*B. fumosipes* Pk. Frequent. Very abundant in

one small grove of evergreen oaks.  
*B. pallidus* Frost. Frequent.  
*B. pictiformis* Murr. A dozen specimens were found. Young stages revealed a smooth cuticle, soon cracking, assuming a scaly appearance with age.  
*B. pisciodorus* Murr. Common. Several collections were made about hardwoods and palms.  
*B. plumboviolaceus* Snell & Dick. Abundant.  
*B. praeanisatus* Murr. Common.  
*B. roseolabus* Murr. Common.  
*B. Russellii* Frost. Three small collections were made of this rare and beautiful species.  
*B. scaber* Bull. ex. Fr. Tawny variety common; pallid variety rare. A form of the pallid variety is Singer's *chalybaeus*.  
*B. stramineus* Murr. One collection.

*B. subflavidus* Murr. Two collections.  
*B. subvelutipes* Pk. Two collections.

*proximus* (Sing.) Murr. One collection.

## BOLETINUS Auct.

*B. merulioides* (Schw.) Coker & Beers, var.

## STROBILOMYCES Berk.

*S. floccopus* (Vahl ex Fr.) Karst. Frequent.

August 22-30

## BOLETUS Auct.

*B. affinis* Pk. Frequent.  
*B. abellus* Pk. Rare.  
*B. alboater* Schw. Rare.  
*B. ananas* M. A. Curt. Rare.  
*B. aureissimus* Murr. Frequent.  
*B. bicolor* Pk. Frequent.  
*B. biporus* Murr. Rare.  
*B. cyanescens* Bull. ex Fr. Rare.  
*B. edulis* Bull. ex Fr. Common.  
*B. flavimarginatus* Murr. Frequent.  
*B. flavissimus* Murr. Rare.  
*B. floridanus* (Sing.) Murr. Common.  
*B. fraternus* Pk. Frequent.  
*B. fumosipes* Pk. Frequent.  
*B. luridellus* Murr. Rare.  
*B. luridiceps* Murr. Rare.  
*B. luteus* L. ex Fr. var. *cothurnatus* (Sing.) Murr. Rare.

*B. pallidus* Frost. Rare.  
*B. pictiformis* Murr. Frequent.  
*B. pisciodorus* Murr. Frequent.  
*B. plumboviolaceus* Snell & Dick. Frequent.  
*B. praeanisatus* Murr. Abundant.  
*B. rosealbus* Murr. Common.  
*B. scaber* Bull. ex Fr. Tawny variety common; pallid variety rare. A form of the latter is Singer's *chalybaeus*.  
*B. stramineus* Murr. Rare.  
*B. subvelutipes* Pk. Frequent.

## BOLETINUS Auct.

*B. merulioides* (Schw.) Coker & Beers, var.  
*proximus* (Sing.) Murr. Rare.

## STROBILOMYCES Berk.

*S. floccopus* (Vahl ex Fr.) Karst. Rare.

September, 1947

A rainless week closed the second mushroom season. Toward the middle of September small specimens of *Coprinus*, *Naucoria* and *Galera* appeared on the lawns, owing to a few daily showers, but these soon disappeared. From Sept. 13 to Sept. 16 there was no rain and everything became very dry; but on Sept. 17 a hurricane struck southern Florida and we had a heavy rain in Gainesville which lasted through the night and all next day.

The first boletes seen during the month appeared on Sept. 20. There were a few plants of *floridanus*, *bicolor*, *praeanisatus* and the tawny form of *scaber*. Lack of rain prevented any more from developing. Sept. 19-21 were rainless days, but on Sept. 22 there was a good shower followed by heavy rains during the night and all next day. This developed several species of boletes, which are listed below.

## BOLETUS Auct.

*B. aureissimus* Murr. Rare.  
*B. bicolor* Pk. Abundant.  
*B. brevipes* Pk. Rare.  
*B. cyanescens* Bull. ex Fr. Rare.  
*B. edulis* Bull. ex Fr. Rare.  
*B. flavimarginatus* Murr. Rare.

*B. flavissimus* Murr. Rare.  
*B. floridanus* (Sing.) Murr. Common.  
*B. luridiceps* Murr. Rare.  
*B. pisciodorus* Murr. Rare.  
*B. plumboviolaceus* Snell & Dick. Rare.  
*B. praeanisatus* Murr. Common.  
*B. rosealbus* Murr. Frequent.  
*B. scaber* Bull. ex Fr. Tawny variety frequent.

October, 1947

The first half was mostly dry and boletes were very scarce. I found a few specimens of *bicolor*, *edulis*, *flavimarginatus*, *plumboviolaceus*, and *rosealbus*. On Oct. 15 there was a four-inch rain, lasting through the night, and about a week later two good showers. These rains, with continuous warm weather, brought out a fine crop of fleshy fungi during the latter part of the month. The boletes found by me in Gainesville in October are listed below.

## BOLETUS Auct.

*B. aureissimus* Murr. Rare.  
*B. bicolor* Pk. Frequent.  
*B. biporus* Murr. Rare.  
*B. brevipes* Pk. Rare.  
*B. edulis* Bull. ex Fr. Common.  
*B. flavimarginatus* Murr. Rare.  
*B. flavissimus* Murr. Rare.  
*B. floridanus* (Sing.) Murr. Frequent.  
*B. fraternus* Pk. Rare.  
*B. fumosipes* Pk. Rare.  
*B. luridellus* Murr. Frequent.

*B. luteus* L. ex Fr. var. *cothurnatus* (Sing.)  
 Murr. Rare.  
*B. pallidus* Frost. Rare.  
*B. pictiformis* Murr. Rare.  
*B. plumboviolaceus* Snell & Dick. Rare.  
*B. praeanisatus* Murr. Common.  
*B. rosealbus* Murr. Common.  
*B. scaber* Bull. ex Fr. Tawny variety common.  
*B. stramineus* Murr. Rare.  
*B. subvelutipes* Pk. Rare.

## STROBILOMYCES Berk.

*S. floccopus* (Vahl ex Fr.) Karst. Rare.

November 1-15, 1947

On Nov. 1 there was a good rain, the first for more than a week. This brought out eight species of boletes by Nov. 4. On Nov. 7 one and one-half inches of rain fell, but the next day a cold wave stopped all mushroom growth with a temperature of 40° F. Warm weather then developed many boletes until Nov. 15, when it became too dry. A list of species collected in Gainesville follows.

## BOLETUS Auct.

*B. aureissimus* Murr. Rare.  
*B. brevipes* Pk. Abundant.  
*B. castaneus* Bull. ex Fr. Rare.  
*B. edulis* Bull. ex Fr. Frequent.  
*B. flavimarginatus* Murr. Rare.  
*B. floridanus* (Sing.) Murr. Rare.  
*B. fumosipes* Pk. Rare.

*B. luteus* L. ex Fr. var. *cothurnatus* (Sing.)  
 Murr. Rare.  
*B. pallidus* Frost. Rare.  
*B. pictiformis* Murr. Rare.  
*B. pisciodorus* Murr. Abundant.  
*B. praeanisatus* Murr. Common.  
*B. pulverulentus* Opat. Rare.  
*B. scaber* Bull. ex Fr. Tawny variety frequent.

## ECOLOGY OF FLORIDA BOLETES

It takes considerable rain to bring out a crop of boletes, and those on lawns respond more quickly than species growing in woods. Most of our species fruit in the summer. A few northern kinds, however, appear only in mild rainy periods during the other seasons. This is in keeping with what we find in certain other fleshy fungi. *Armillaria mellea*, for example, rarely appears here before December.

Shade is also essential for most boletes. They feed upon the humus found under trees. Some have a narrow range of adaptation, while others can flourish in a wide range of habitats. The most important division of tree hosts is into conifers and frondose trees, but a few species can even cross that broad gap. Few are found in what we call "flatwoods," which are low stretches of slash or longleaf pine containing moist, acid soil. Evergreen oaks usually harbor different species from those found under deciduous oaks.

Much has been written about mycorrhizas, and lists of temperate boletes with their special tree hosts have been made, but nothing has been done in Florida to add to what we already knew. I believe that when a northern bolete entered the new land called "Florida" it either got along with the

tree hosts found here or disappeared. The fact that a certain northern tree is not found here is no proof that a certain northern bolete is not. Dr. Walter Thomas recently wrote, "The weight of evidence is that mycorrhiza-forming fungi function with respect to supplying food to plants in the same manner as do all other soil organisms, that is, by the decomposition of organic matter." In other words, it is the humus under the tree host that is important.

#### NEW FLORIDA SPECIES

These have been recently collected in the Gainesville area. A few other new species and varieties are being studied to obtain more data. As long as field work continues there will be novelties.

#### ***Boletus flaviceps* sp. nov.**

Pileo convexo-subdepresso, 6 cm. lato, flavo, grato; tubulis 1 cm. longis, parvis, olivaceis; sporis  $13-15 \times 4-5\mu$ ; stipite reticulato, griseoflavo,  $3-4 \times 1-2.5$  cm.

Pileus convex to slightly depressed like a saucer, gregarious, about 6 cm. broad; surface dry, glabrous, uniformly flavous with reddish stains, becoming finely checked in places, margin even, entire, concolorous, fertile; context 1 cm. or more thick, odorless, sweet and nutty, pale-yellow, becoming light-blue at once when wounded, flavous in old cracks; tubes deeply depressed at stipe. 1 cm. or more long, small, slightly decurrent, at maturity dull-olive with a sulphur tint, darker olive where bruised; spores oblong-fusiform, smooth, not guttulate, yellowish-brown,  $13-15 \times 4-5\mu$ ; stipe equal or much enlarged upward, lightly reticulate over most of its surface, flavous at apex, grayish-yellow below, purple at base, about  $3-4 \times 1-2.5$  cm.

Type collected by W. A. Murrill on a lawn near old longleaf pines in Gainesville, Fla., July 26, 1947 (*F* 39218). Little changed in drying except the reddish stains on the cap mostly disappear, while the base of the stipe remains purple.

#### ***Boletus fulvipallidus* sp. nov.**

Pileo convexo, 5 cm. lato, fulvo, subrugoso, felleo; tubulis depressis, 7 mm. longis, parvis, albis, demum stramineis; sporis  $10-12 \times 4-5\mu$ ; stipite subfulvo,  $5 \times 1.5$  cm.

Pileus convex, solitary, 5 cm. broad; surface dry, fulvous, glabrous, slightly pitted and rugose, margin even, entire, concolorous, fertile; context 5 mm. or more thick, white, unchanging, distinctly bitter, with anise odor; hymenium plane, deeply depressed behind, tubes 7 mm. long, small but variable, white to straw-colored, unchanging when wounded; spore oblong-ellipsoid, smooth, pale-yellowish-brown, uniguttulate,  $10-12 \times 4-5\mu$ ; stipe

equal, solid, smooth, glabrous, subconcolorous, brownish within when bruised,  $5 \times 1.5$  cm.

Type collected by W. A. Murrill on a grassy lawn near a laurel oak in Gainesville, Fla., Oct. 31, 1947 (*F 18670*). Little changed in drying; but the margin becomes sharply inflexed.

***Boletus pallidiceps* sp. nov.**

Pileo convexo, 5-6 cm. lato, pallido, subfelleo; tubulis 1.5 cm. longis, parvis, ochroleucis, cyanescentibus, demum brunneis; sporis  $12 \times 4\mu$ ; stipite rubro-purpureo,  $4-5 \times 1-1.5$  cm.

Pileus convex, gregarious, about 5-6 cm. broad; surface dry, soft, smooth, pallid, margin entire, narrowly projecting, incurved; context 2 cm. thick, white, soon changing to pale-blue when cut, odorless, at first mild and mucilaginous, at length slightly bitter and astringent; hymenium plane, slightly depressed at stipe and decurrent, tubes small, angular, 1.5 cm. long, pale-yellow, turning greenish-blue at once when wounded and finally browning on the edges; spores oblong-ellipsoid, smooth, pale-yellowish-brown, about  $12 \times 4\mu$ ; stipe about equal, lemon-yellow at the apex, then with bright-red-purple lines and granules nearly to the pale base, about  $4.5 \times 1-1.5$  cm.

Type collected by W. A. Murrill under frondose trees on the edge of a sink in Gainesville, Fla., Sept. 19, 1944 (*F 19296*). Also collected by me on a lawn under water oaks in Gainesville, Aug. 30, 1947 (*F 17294*); in grass under a laurel oak in Gainesville, July 23, 1947 (*F 8548*); and on a damp grassy lawn under a laurel oak in Gainesville, Sept. 23, 1946 (*F 18783*). near *B. pallidus* Frost.

***Boletus purpurellus* sp. nov.**

Pileo convexo, 6 cm. lato, purpureo-rubro, grato; tubulis depressis, 1-1.5 cm. longis, parvis, flavis, cyanescentibus; sporis  $12-15 \times 5-6\mu$ ; stipite flavo et purpureo,  $7 \times 1-1.7$  cm.

Pileus broadly convex, solitary, about 6 cm. broad; surface dry, smooth, glabrous, purple-red, slightly paler toward the margin, which is entire, even, fertile, with narrow flavous edge; context 1 cm. or more thick, soft, mild, odorless, bluing at once when wounded; tubes deeply depressed at stipe, 1-1.5 cm. long, small, not stuffed, yellow to greenish-yellow, bluing at once when cut; spores oblong-fusiform, smooth, pale-yellowish-brown, not guttulate,  $12-15 \times 5-6\mu$ ; stipe tapering upward, yellow at apex, streaked and rough, purple over yellow, with fine purplish scurf,  $7 \times 1-1.7$  cm.

Type collected by W. A. Murrill under a laurel oak in Gainesville, Fla., July 24, 1947 (*F 39219*). Also collected by me in Gainesville under the same host on Oct. 26, 1947 (*F 39226*). Beautiful and rare.

## Cercosporae of China—II<sup>1</sup>

T. L. TAI<sup>2</sup>

In a previous paper (Bull. Chin. Bot. Soc. 2: 45-66, 5 pls., 1936) the writer reported 55 species of *Cercospora* from China. The number of Cercosporae reported to occur in China up to 1943 is 108 species.<sup>3</sup> Sixty species of *Cercospora*, mostly from Yunnan are recorded in this paper. Of these, 19 reported in the first paper are here listed again for new hosts or new localities, 12 are new records for China and 10 new to science. The addition of 22 species brings the total number of Chinese Cercosporae to 130.

For convenience the species are arranged alphabetically. Full descriptions are given for most of the species listed below in order to facilitate checking misidentifications.

### CERCOSPORA ALEURIDITIS Miyake

Spots angular, purplish brown on the upper surface, 2-5 mm. wide, smoky brown on the lower surface; fruiting amphigenous, stroma present, 20-47 $\mu$  in diameter; conidiophores in fascicles of 5 to 37, often geniculate, subequal in width, sometimes branched, straight or slightly curved, sometimes subflexuous, olivaceous brown, 2-3 septate, 33-63 $\times$ 4-6 $\mu$ , spore scar not conspicuous; conidia at first cylindrical, becoming obclavate or clavate-cylindrical with conico-truncate base, occasionally nodulose, usually straight or slightly curved, indistinctly septate (6-11?), pale olivaceous, 71-114 $\times$ 4.0-5.4 $\mu$ .

On *Aleurites Fordii*, Hunan: Yolushan, Changsha, Nov. 26, 1937, C. C. Cheo and S. T. Chao 5994.<sup>4</sup> Kwangsi: Liuchow, Oct. 8, 1939, L. Hwang (Hwang 296).

This species was described from Sangteh, Hunan by Miyake in 1912. In the original diagnosis by Miyake the conidia were described as hyaline.

### CERCOSPORA ALTHAEINA Sacc.

On *Althaea rosea*, Kansu: Langchow, July 30, 1941, W. N. Siang (Siang 87); Sept. 6, 1942, W. N. Siang (Siang 232).

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<sup>3</sup> An unpublished manuscript by Dr. C. S. Wang, "An enumeration of plant diseases of Honan—I" (in Chinese, 160 pages, 1942), contains 36 species of *Cercospora*, seven of which are new records for China (up to 1942): *C. Fagopyri* Nak. et Tak., *C. Setariae* Atk., *C. concors* (Casp.) Sacc., *C. carotae* (Pass.) Solh., *C. Dahliae* Hara, *C. Paulowniae* Hori, *C. Clerodendri* Miyake.

<sup>4</sup> This refers to the accession number of the Plant Pathology Herbarium of Tsing Hua University.



FIG. 1. *Cercospora viburnicola* sp. nov.      FIG. 4. *Cercospora Camptothecae* sp. nov.  
FIG. 2. *Cercospora Amaranthi* Lobik      FIG. 5. *Cercospora chengtzensis* sp. nov.  
FIG. 3. *Cercospora Pileae* sp. nov.      FIG. 6. *Cercospora Coriariae* sp. nov.  
FIG. 7. *Cercospora Pisi-sativi* Stevenson

## CERCOSPORA AMARANTHI Lobik

Fig. 2

Spots suborbicular, brown with definite dark brown depressed margin, 1-2 mm. in diameter; fruiting amphigenous, stroma small, 11-18 $\mu$  in diameter; conidiophores in loose fascicles, subflexuous, subgibbose, tip truncate, tapering towards apex, sometimes branched, olivaceous brown, 0-3 septate, 37-94 $\times$ 3.6-6.0 $\mu$ , spore scars evident, usually crowded near the apex, about 2 $\mu$  wide, shouldered; conidia clavate-cylindrical to obclavate with truncate base, subhyaline, 6-20 septate, 46-104 $\times$ 3.6-4.3 $\mu$ .

On *Amaranthus gangeticus*, Kwangtung: Canton, July 1938, L. T. Lin.

This collection differs from *C. brachiata* by its different spot, shorter and wider conidiophore and conidia, but is very close to *C. Amaranthi*, described by Lobik from the Terek district of U.S.S.R. in 1928, except that its spots are not zonate and the conidia are subhyaline.

## CERCOSPORA AMORPHOPHALLI P. Henn.

Spots suborbicular or angular, center gray with grayish brown concentric rings, sometimes confluent (at first small, grayish brown with dark brown indefinite border), 1.5-5 mm. wide; fruiting amphigenous, stroma present, loose, 20-29 $\mu$  in diameter; conidiophores in dense fascicles, usually straight or slightly curved, subequal in width, truncate at the apex, 0-1 septate, olivaceous brown, 31-51 $\times$ 4.3 $\mu$ , spore scars conspicuous, 2-3 $\mu$  wide, shouldered; conidia clavate-cylindrical, subhyaline, 3-9, usually 7 septate, 67-91 $\times$ 3.5-4.3 $\mu$ .

On *Hydrosome Rivieri* (*Amorphophallus R.*), Yunnan: Lunan, Aug. 1939, L. T. Lin.

Differs from *C. protensa* Syd. by its different spot, shorter and rarely septate conidiophores and light colored conidia.

## CERCOSPORA APII Fres.

On *Apium graveolens*, Yunnan: Kunming, Dec. 1938, T. F. Yu, 5967; Shihping, Dec. 20, 1938, H. S. Yao, 6939. Kansu: Langchow, Aug. 3, 1941 (Siang 149); Wuwi, Aug. 18, 1941, W. N. Siang (Siang 118).

## CERCOSPORA ARACHIDICOLA Hori

Dark brown orbicular spots, not thickened, 3-4 mm. in diameter; fruiting epiphyllous, stroma present, 10-20 (us. 10-11 $\mu$ )  $\mu$  in diameter; conidiophores densely tufted, yellowish brown, 21-33 $\times$ 4.3-5.0 $\mu$ , straight or slightly curved, 0-2 septate, slightly attenuated towards the apex; conidia obclavate, olivaceous, 2-8 septate (us. 5), base truncate, more or less curved, usually straight, 46-93 $\times$ 4-5 $\mu$ .

On *Arachis hypogaea*, Yunnan: Pinchwan, Sept. 22, 1938, C. C. Cheo,

6871, 6872. Kwangsi: Liuchow, June 23, 1939, L. Hwang and T. C. Loh (Hwang 249).

CERCOSPORA BETICOLA Sacc.

Spots orbicular, at first dirty brown (yellow on *Spinacia*) with definite raised dark brown border (yellowish green on *Spinacia*), center becoming whitish or white, 1–2.5 mm. in diameter; fruiting amphigenous, stroma present, loose, 16–37 $\mu$  in diameter; conidiophores in loose tufts, straight or more or less curved, equal in width or tapering towards the apex, truncate at tip, not branched, usually non-septate, rarely 1–3 septate, olivaceous brown, often zigzag at the upper half, 14–86 $\times$ 4–6 $\mu$ , spore scar conspicuous, about 3 $\mu$  wide; conidia obclavate or acicular-obclavate, base subconico-truncate or truncate, straight or often curved at the upper half, not constricted at septum, 44–100 $\times$ 3–4.3 $\mu$ , hyaline.

On *Beta vulgaris*, Yunnan: Kunming, Dec. 1938, T. F. Yu, 5966; Nov. 23, 1938, T. F. Yu, 5986; Chengkung, Oct. 1939, C. H. Hung, 6319. Szechuan: Neikiang, Oct. 16, 1939, L. Ling (Ling 75). Kansu: Langchow: Sept. 6, 1942, W. N. Siang (Siang 230). *Spinacia oleracea*, Szechuan, Tzechung, Nov. 11, 1939, L. Ling (Ling 202).

**Cercospora Camptothecae** sp. nov.

Fig. 4

Maculis orbicularibus v. irregularibus, griseis, zona atro-brunnea cinctis, 1.5–8 mm. diam.; caespitulis epiphyllis, stroma 29–43 $\mu$  diam.; conidiophoris dense fasciculatis, rectis v. leniter curvatis, simplicibus, subflexuosis, gibbosis, plerumque sursum attenuatis, 0–4 septatis, olivaceo-brunneis, 37–60 $\times$ 3.6–4.3 $\mu$ ; conidiis clavato-cylindraceis, 3–6 septatis, subhyalinis, 40–100 $\times$ 2.9–3.6 $\mu$ .

Spots orbicular or irregular, center whitish surrounded with an indefinite dark brown zone, 1.5–8 mm. in diameter; fruiting epiphyllous, stroma present, 29–43 $\mu$  wide; conidiophores in dense fascicles, straight or occasionally slightly curved, not branched, gibbous, subflexuous, usually attenuated towards the apex, 0–4 septate, olivaceous brown, 37–60 $\times$ 3.6–4.3 $\mu$ , spore scars evident, 2–3 $\mu$  wide; conidia clavate-cylindrical, distinctly 3–6 septate, subhyaline, truncate at base, 40–100 $\times$ 2.9–3.6 $\mu$ .

On *Camptotheca acuminata*, Szechuan: Chengtu, Nov. 26, 1937, L. Ling (Ling 222).

CERCOSPORA CANESCENS Ell. et Mart.

On *Phaseolus vulgaris*, Yunnan: Kunming, June 26, 1938, C. C. Cheo, 5970. *Phaseolus aureus*, Yunnan: Hwaning, Aug. 20, 1938, S. T. Chao, 5885; Lufung, Aug. 20, 1938, C. H. Hung, 5945. *Vigna sinensis*, Yunnan:

Tali, Aug. 1938, C. C. Cheo, 5958; Kaiyuan, Aug. 4, 1938, S. T. Chao and T. H. Wang, 5954; Wenshan, Aug. 1938, S. T. Chao and T. H. Wang, 5953. Kwangsi: Liuchow, Oct. 9, 1939, T. S. Lo (Hwang 313). *Dolichos lablab*, Kwangsi: Liuchow, Oct. 7, 1939, L. Hwang and T. S. Lo (Hwang 308).

#### CERCOSPORA CAPSICI Heald et Wolf

Subcircular spots, 1-5 up to 8 mm. in diameter, brown becoming grayish brown, raised on the upper surface, surrounded with raised dark brown border; fruiting amphigenous, effuse on the under surface of the spots, forming a sooty layer, stroma present, 23-37 $\mu$  in diameter; conidiophores in dense fascicles, straight or slightly curved, subflexuous, conico-truncate at tip, often subdenticulate at the distal end, 1-2 septate, olivaceous brown, 33-86 $\times$ 5-5.7 $\mu$ ; conidia cylindrical or clavate-cylindrical, often nodulose and constricted at septum, 1-5 septate, olivaceous or subhyaline with conico-truncate base, 57-117 $\times$ 4-6 $\mu$ .

On *Capsicum annuum*, Yunnan: Kunming, Oct. 1939, K. T. King, 5950.

#### CERCOSPORA CAROTAE (Passerini) Solheim

Spots on the leaf and also on the stem, suborbicular or oblong, 0.3-1.2 mm. wide, brownish with a purplish black definite border; fruiting amphigenous, stroma absent, conidiophores spreading, slightly curved, subflexuous, tapering towards the apex, with or without a bulbous base, 0-2 indistinctly septate, olivaceous, 21-34 $\times$ 3.6-5.0 $\mu$ , spore scars minute; conidia clavate-cylindrical, subhyaline, indistinctly 3-8 septate, base conico-truncate, 51-74 $\times$ 2.9-4.0 $\mu$ .

On *Daucus carota*, Szechuan: Tzechung, Nov. 7, 1937, L. Ling (Ling 37).

#### CERCOSPORA CELOSIAE Syd.

On *Celosia crestata*, Honan: Chengping, Sept. 1938, C. S. Wang (Wang 1381).

#### **Cercospora chengtuenensis** sp. nov.

Fig. 5

Maculis indistinctis decoloris; caespitulis hypophyllis, effusis, velutinis in macula rotundata 1-1.5 mm. diam.; stroma 19-25 $\mu$  diam.; conidiophoris dense fasciculatis, lenissime curvulis, simplicibus, rarius ramosis, subflexuosis, undulatis, 1-5 septatis, olivaceo-brunneis, 29-77 $\times$ 3-4 $\mu$ ; conidiis subcylindraceis v. clavato-cylindraceis, olivaceis, 3-14 septatis, 46-99 $\times$ 3.6-5.4 $\mu$ .

Indefinite discolored spots on the upper surface; fruiting hypophyllous in an effuse sooty olivaceous layer, forming roundish spots on the lower

surface, 1-1.5 mm. in diameter, stroma present, 19-25 $\mu$  wide; conidiophores densely clustered, slightly curved, rarely branched near the base, undulating, subflexuous, 1-5 septate, olivaceous or pale olivaceous brown, 29-77 $\times$ 3-4 $\mu$ , spore scars not conspicuous, shouldered; conidia subcylindrical to clavate-cylindrical, olivaceous, 3-14 septate, septation often indistinct, base conico-truncate, 46-99 $\times$ 3.6-5.4 $\mu$ .

On *Lycium chinensis*, Szechuan: Chengtu, 1943, L. Ling (Ling 126). Differs from *C. Lycii* Ellis et Halsted in different spot, shorter and wider conidia.

#### CERCOSPORA CHRYSANTHEMI Heald et Wolf

Suborbicular or oval definite brownish spots, center becoming grayish with age, bounded by a narrow dark brown zone, 1-4 mm. wide; fruiting amphigenous, stroma absent; conidiophores densely fasciculate, straight, slightly curved or subflexuous, gibbous, rarely branched, subdenticulate and crowded with scars near the apex, brown, 0-3 septate, 40-70 $\times$ 3.0-5.4 $\mu$ , spore scar evident, shouldered, about 2 $\mu$  wide; conidia cylindrical-clavate or clavate, subhyaline, with truncate base, 7-11 septate, 51-90 $\times$ 3-4 $\mu$ .

On *Chrysanthemum coronarium*, Szechuan: Chengtu, Nov. 23, 1937, L. Ling (Ling 5). Kwangsi: Liuchow, May 1, 1940, L. Hwang (Hwang 312).

#### CERCOSPORA CIRCUMSCISSA Sacc.

Spots suborbicular or irregular, 2-10 mm. in diameter, brownish with purplish brown border, center becoming ashy with age; fruiting epiphyllous, stroma present 37-75 $\mu$  in diameter; conidiophores densely fasciculate, straight or slightly curved, occasionally branched, slightly attenuated toward apex, 1-3 septate, more or less constricted at septum, olivaceous brown, darker below, 26-37 $\times$ 3-4 $\mu$ ; conidia subcylindrical or clavate-cylindrical, subhyaline, the cells of the conidium often abruptly constricted, 21-52 $\times$ 2.8-4.0 $\mu$ , 2-7 septate, base conico-truncate.

On *Eriobotrya japonica*, Yunnan: Lunan, Oct. 1939, C. H. Hung, 5676. Szechuan: Chengtu, Nov. 22, 1937, L. Ling (Ling 22). Hunan: Kwanghsien Jan. 7, 1938, F. L. Tai, 5792.

*Cercosporina Eriobotryae* Enjoji is doubtless synonymous with *C. circumscissa*.

#### CERCOSPORA CITRULLINA Cooke

Spots roundish somewhat angular with white center, surrounded by a definite slightly raised dark brown border, 1-3 mm. in diameter; fruiting epiphyllous, stroma present, 19-37 $\mu$  in diameter; conidiophores few (3-5) in loose fascicles, straight or subflexuous, rarely geniculate, 0-2 septate, olivaceous brown, truncate at tip, tapering near the apex, 34-66 $\times$ 5.0-5.7 $\mu$ ,

spore scar evident,  $3.5-4.3\mu$  wide; conidia acicular-obclavate, subconico-truncate at base, subhyaline, 8-13 septate,  $57-104 \times 3.6-4.3\mu$ .

On *Luffa cylindrica*, Yunnan: Kunming, Nov. 1943, F. L. Tai, 8552. Hara described *Cercosporina Luffae* (Hara, K.—Pathologia Agriculturae Plantarum (in Japanese) p. 465, 1934) from the same host. The Yunnan form agrees closely with the description of Hara's species, but the latter does not seem to differ essentially from *C. citrullina* Cooke to which the Yunnan fungus is referred.

#### CERCOSPORA CLERODENDRI Miyake

Spots angular, brown with a narrow raised dark brown border, 2-11 mm. wide, 5-10 mm. long; fruiting amphigenous, stroma present, small,  $14-21\mu$  wide; conidiophores in loose fascicles, straight or subflexuous, occasionally geniculate, denticulate near the apex, slightly tapering toward apex, 0-3 septate, olivaceous brown,  $31-57 \times 3.5-5.7\mu$ .

On *Clerodendron trichotomum*, Honan: Chengping, Sept. 1938, C. S. Wang (Wang 207). Differs from *C. Bakeri* by its shorter conidiophore and longer and narrower conidia.

#### CERCOSPORA COFFEICOLA B. et C.

Roundish spots, dark brown above with a gray center, 8-10 mm. in diameter, pale brown below; fruiting amphigenous, mainly hypophyllous, stroma compact, dark brown to black,  $26-43\mu$  in diameter; conidiophores in loose fascicles, subflexuous and denticulate above, not branched, 4-7 septate, olivaceous brown,  $137-263 \times 4.5-6.0\mu$ , spore scar evident, about  $3\mu$  in diameter; conidia acicular or acicular-obclavate, truncate or subconico-truncate at base, usually curved at the upper part, hyaline, 10-16 septate,  $94-205 \times 3.6-4.3\mu$ .

On *Coffea arabica*, Yunnan: Hokow, Feb. 16, 1939, C. C. Cheo; Kaiyuan, Dec. 16, 1938, T. F. Yu, Wang and Chao, 5984.

#### CERCOSPORA COLUMNARIS Ell. et Ev.

Angular definite brown spots, sometimes confluent, usually 2-5 mm. wide; fruiting amphigenous, stroma present,  $26-31\mu$  in diameter; conidiophores in a coremium ( $25-37\mu$  wide), 30-40 in number, straight, subflexuous or curved near the apex, olivaceous brown, 0-2 remotely septate, occasionally subdenticulate near the apex,  $187-237 \times 4-6\mu$ , spore scar distinct, about  $2.8\mu$  wide; conidia clavate-cylindrical, usually curved, 3-7 septate, conico-truncate at base, pale olivaceous,  $51-66 \times 5.7-7.2\mu$ .

On *Phaseolus vulgaris*, Yunnan: Kunming, Aug. 1942, H. R. Wang, 7932. This species is no doubt identical with *Isariopsis griseola* Sacc. as mentioned by Keissler (Ann. Myc. 21: 1923), but the present writer is of the opinion that it should be placed in the genus *Cercospora*.

## CERCOSPORA CONCORDS (Casp.) Sacc.

Spots indefinite, roundish, dark brown above, paler below, 4-8 mm. in diameter; fruiting hypophyllous, effuse, stroma absent; conidiophores arising from procumbent septate branched mycelium, single or in loose clusters, occasionally branched, subequal or usually inflated at the upper two-thirds, subflexuous, slightly curved, 0-1 septate,  $30-51 \times 5-6\mu$ , conidiophores twining about the hairs of the leaf, beadlike chlamydospores within the leaf tissue, spore scar not conspicuous; conidia subcylindrical or clavate-cylindrical, with rounded obtuse apex and conical base, straight or slightly curved, olivaceous, 3-6 septate, not constricted at septum,  $30-60 \times 4-6\mu$ .

On *Solanum tuberosum*, Honan: Sunghsien, Aug. 1940, C. S. Wang (Wang 752).

**Cercospora Coriariae** sp. nov.

Fig. 6

Maculis distinctis rotundatis v. interdum angulosis, 2-5 mm. diam., superne atro-brunneis, inferne brunneolis; caespitulis amphigenis, stroma  $20-43\mu$  lata; conidiophoris laxe fasciculatis, rectis v. lenissime curvulis, subundulatis, 0-1 septatis, simplicibus, olivaceis,  $21-30 \times 2.9-4.3\mu$ ; conidiis obclavatis, 3-6 septatis, pallide olivaceis,  $39-77 \times 2.9-4.6\mu$ .

Spots definite, roundish or angular, 2-5 mm. in diameter, dark brown on the upper surface, brownish below; fruiting amphigenous, usually in the center of the spot, stroma present,  $20-43\mu$  in diameter; conidiophores loosely fasciculate, straight or slightly curved, subundulating, 0-1 septate, not branched, olivaceous,  $21-30 \times 2.9-4.3\mu$ , spore scar not conspicuous; conidia obclavate with conico-truncate base, 3-6 septate, pale olivaceous,  $39-77 \times 2.9-4.6\mu$ .

On *Coriaria sinica*, Szechuan: Kwanhsien, Dec. 4, 1941, T. K. Li (Ling 123), type. According to Dr. Charles Chupp this species has also been collected in Colombia by Chardon.

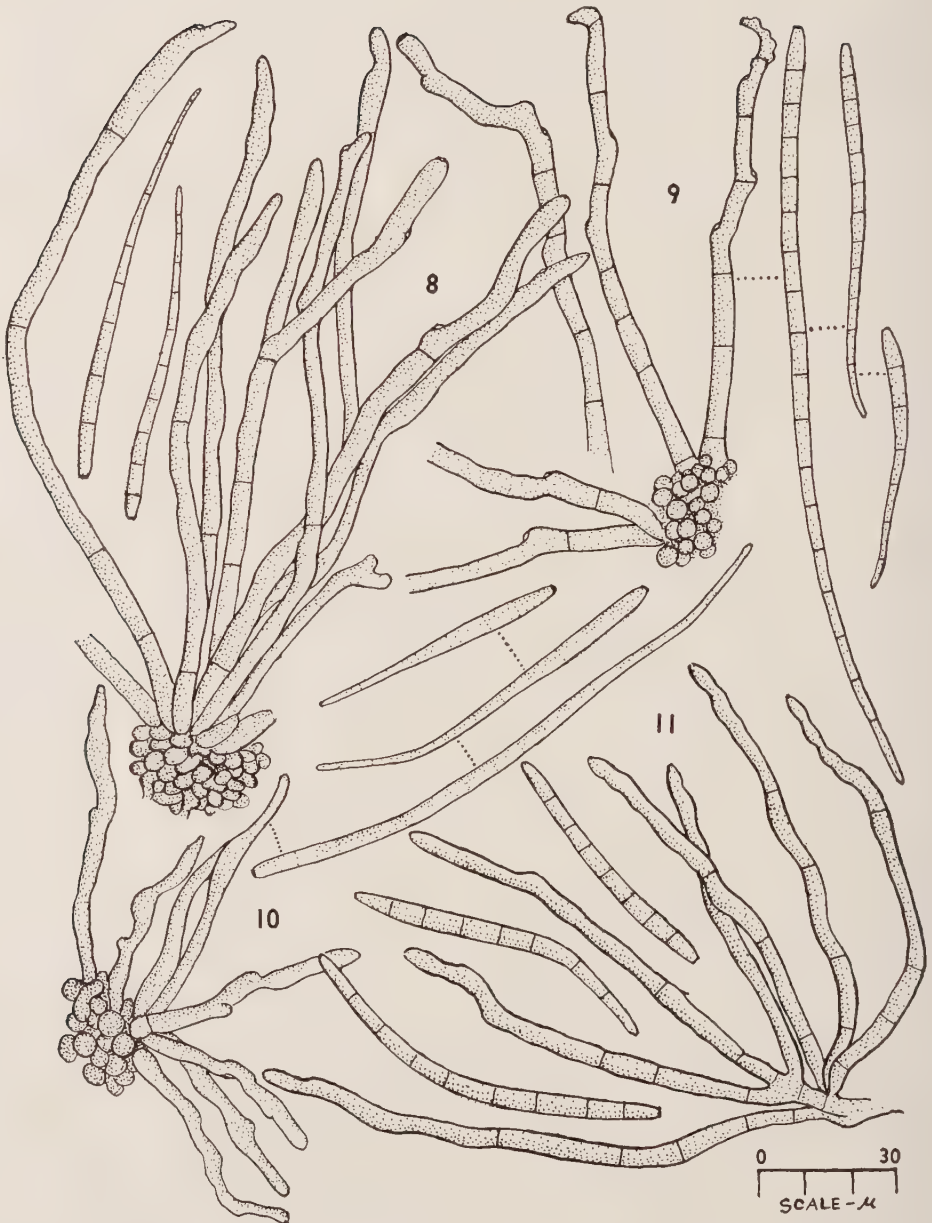
## CERCOSPORA CRUENTA Sacc.

On *Vigna sinensis*, Yunnan: Kunming, Oct. 15, 1938, T. H. Wang, 4829. Szechuan: Pehpei, Aug. 23, 1932, F. L. Tai, 8517. Kwangtung: Canton, 1933, L. T. Lin, 5682.

## CERCOSPORA DAHLIAE Hara

Fig. 15

Spots at first roundish, small, white, then the surrounding areas becoming dark brown, irregular in shape, border definite, with a gray center, 0.5-1 cm. wide, confluent; fruiting epiphyllous, stroma present, small,  $14-23\mu$

FIG. 8. *Cercospora szechuanensis* sp. nov.FIG. 9. *Cercospora justiciaecola* sp. nov.FIG. 10. *Cercospora sapindicola* sp. nov.FIG. 11. *Cercospora Justiciae* sp. nov.

in diameter; conidiophores in loose fascicles, 3-7 in number, subflexuous, geniculate, subequal in width,  $112-180 \times 4-6\mu$ , spore scars conspicuous about  $4\mu$  wide, 5-7 septate, brown; conidia clavate-cylindrical, 8-14 septate, not constricted at septum, usually more or less curved, hyaline,  $72-187 \times 3.5-5.0\mu$ , with truncate base.

On *Dahlia variabilis*, Honan: Nanyang, Sept. 1938, C. S. Wang (Wang 224). Differs from *C. grandissima* by its non-denticulate apex of the conidiophore, shorter and much wider conidia.

#### CERCOSPORA DATURICOLA Speg.

Fig. 13

Spots roundish, all over the leaf surface, 1-3 mm. in diameter, definite, ashy center, surrounded by concentric brown rings; fruiting amphigenous, stroma  $16-26\mu$  in diameter; conidiophores in loose fascicles, straight, more or less undulating, truncate at tip,  $116-143 \times 4.3-5.7\mu$ , olivaceous brown, 3-5 septate, spore scar conspicuous, about  $4\mu$  wide; conidia acicular-obclavate, 9-16 septate, truncate or subconico-truncate at base,  $81-146 \times 3.6-4.3\mu$ , hyaline.

On *Datura alba*, Szechuan: Chengtu, Oct. 1943, L. Ling (Ling 149). This collection is referred to *C. daturicola* with some hesitation. It is very close to the latter except the septation of the spores.

#### CERCOSPORA DIFFUSA Ell. et Ev.

Spots indefinite, brown, orbicular, 2-5 mm. in diameter; fruiting amphigenous, effuse, stroma small,  $14-17\mu$  in diameter; conidiophores in dense fascicles, sometimes branched, straight or slightly curved, subflexuous, subgibbous, rarely geniculate, 0-1 septate, olivaceous,  $29-51 \times 3.6-4.3\mu$ , spore scars indistinct; conidia subcylindrical, straight, slightly curved or rarely geniculate with conico-truncate base, indistinctly septate (5-12), subhyaline,  $44-93 \times 3.6-4.3\mu$ .

On *Lycopersicum esculentum*, Kwangsi: Liuchow, Aug. 19, 1939, W. N. Siang (Hwang 310).

#### CERCOSPORA EUPHORBIAE Kell. et Sw.

Spots gray, bounded by an indefinite dark brown zone, orbicular, 1-3 mm. in diameter; fruiting amphigenous, stroma  $29-46\mu$  in diameter; conidiophores in dense fascicles, flexuous, often geniculate, subnodulose, 0-5 septate, olivaceous brown,  $30-229 \times 5-6\mu$ , spore scars conspicuous,  $3.6-4.3\mu$  wide; conidia acicular with truncate base, subhyaline, 10-12 septate,  $66-192 \times 3.6-4.3\mu$ .

On *Euphorbia* sp., Szechuan: Shehung, Sept. 1930, L. Ling. This form agrees well with the description of *C. Euphorbiae* Kell. et Sw. *C. helicoscopiae* Syd. without definite spots and with wider conidia seems to be distinct.

## CERCOSPORA FAGOPYRI Nakata et Takimoto

Fig. 14

Spots orbicular, brownish-red above, inconspicuously concentric, without definite border, center whitish, 5–10 mm. in diameter; fruiting hypophyllous, stroma present, loose,  $17\text{--}23\mu$  in diameter; conidiophores in dense fascicles, straight or slightly curved at the lower part, rarely geniculate, subequal, not branched, 0–3 septate, olivaceous brown,  $40\text{--}60 \times 4\text{--}6\mu$ , spore scars conspicuous, about  $3\mu$  wide, shouldered; conidia acicular or acicular-obclavate, straight or slightly curved, with acute apex and truncate or subconico-truncate base, 5–10 septate, not constricted at septum, olivaceous,  $59\text{--}117 \times 2.9\text{--}4.3\mu$ .

On *Polygonum Fagopyrum*, Honan: Sunghsien, Sept. 1939, C. S. Wang (Wang 459).

## CERCOSPORA GOSSYPINA Cooke

Spots orbicular or irregular, 1.5–3.5 mm. in diameter, often confluent, dark purplish brown with brown center becoming whitish with age; fruiting epiphyllous, grouped in the whitish center, stroma present,  $37\text{--}56\mu$  in diameter; conidiophores subfasciculate, straight or subflexuous, sometimes nodulose, simple, rarely branched, 0–3 septate, brown,  $41\text{--}83 \times 5\text{--}6\mu$ , spore scars conspicuous,  $3.0\text{--}3.6\mu$  wide; conidia subcylindrical or obclavate, with truncate base, 3–8 septate, hyaline,  $39\text{--}93 \times 3.6\text{--}6.5\mu$ .

On *Gossypium barbardense*?, Yunnan: Tachwang, Dec. 18, 1938, T. F. Yu, 5941. *G. sp.*, Yunnan: Niutsin, Sept. 22, 1938, C. C. Cheo, 5940. *G. hirsutum*, Yunnan: Niutsin, Sept. 22, 1938, C. C. Cheo, 5990.

## CERCOSPORA GRANULIFORMIS Ellis et Holway

Indefinite yellowish spots on the upper surface; fruiting in sooty layers on the lower surface, forming orbicular spots, often confluent, 3–8 mm. in diameter, stroma present, small,  $14\text{--}20\mu$  in diameter; conidiophores densely fasciculate, usually branched, subflexuous, occasionally geniculate, gibbous, often constricted at septum, 0–5 septate, brownish olivaceous, slightly curved,  $36\text{--}60 \times 3.6\text{--}4.0\mu$ , spore scars inconspicuous; conidia subcylindrical to narrowly clavate, often abruptly narrowed near the base, contents granular, straight or rarely variously curved, subhyaline, 4–15 septate, base conico-truncate or truncate,  $80\text{--}136 \times 3.6\text{--}4.3\mu$ , sometimes catenulate.

On *Viola sp.*, Szechuan: Chengtu, Dec. 1943, M. C. Tai (Ling 134).

## CERCOSPORA HENNINGSII Allesch

Spots angularly orbicular, brown with a distinct darker border, 2–11 mm. in diameter, rarely confluent; fruiting epiphyllous, stroma present,  $50\text{--}75\mu$  in diameter; conidiophores fasciculate, more or less curved, un-

dulating, 0-1 septate, not branched, olivaceous,  $24-40 \times 4.0-6.4\mu$ , spore scars minute; conidia subcylindrical or clavate-cylindrical, straight or slightly curved, rounded at apex, conico-truncate at the base. 3-11 septate, olivaceous,  $29-94 \times 5.7-6.4\mu$ .

On *Manihot utilissima*, Kwangtung: Canton, July 1938, C. H. Hung, 5677.

#### CERCOSPORA INSTABILIS Rangel

Spots orbicular, pale brown with dark brown border, sometimes confluent, 1.5-3.5 mm. in diameter; fruiting amphigenous, chiefly hypophyllous, usually gregarious in the center of spot, stroma present,  $23-40\mu$  in diameter, tuberculate; conidiophores in dense fascicles, subflexuous, slightly curved, wider at the middle part, pale brown,  $16-40 \times 2.9-3.6\mu$ , spore scars not evident; conidia clavate-cylindrical or obclavate, hyaline with conical base, indistinctly septate (5-7?),  $49-80 \times 2.9-4.3\mu$ .

On *Cajanus indicus*, Kwangsi: Liuchow, Aug. 13, 1939, L. Hwang (Hwang 274).

#### Cercospora Justiciae sp. nov.

Fig. 11

Maculis superne indistinctis, flavidis; caespitulis hypophyllis, effusis, velutinis in macula subrotundata (2.5 mm. diam.), stroma nulla; conidiophoris laxe fasciculatis, rectis v. plerumque curvulis, ad apicem denticulatis, subflexuosis, olivaceo-brunneis, 3-7 septatis,  $57-120 \times 4-5\mu$ ; conidiis primo subcylindratis demum clavato-cylindratis, pallide olivaceis, 5-11 septatis,  $57-101 \times 3.5-5.0\mu$ .

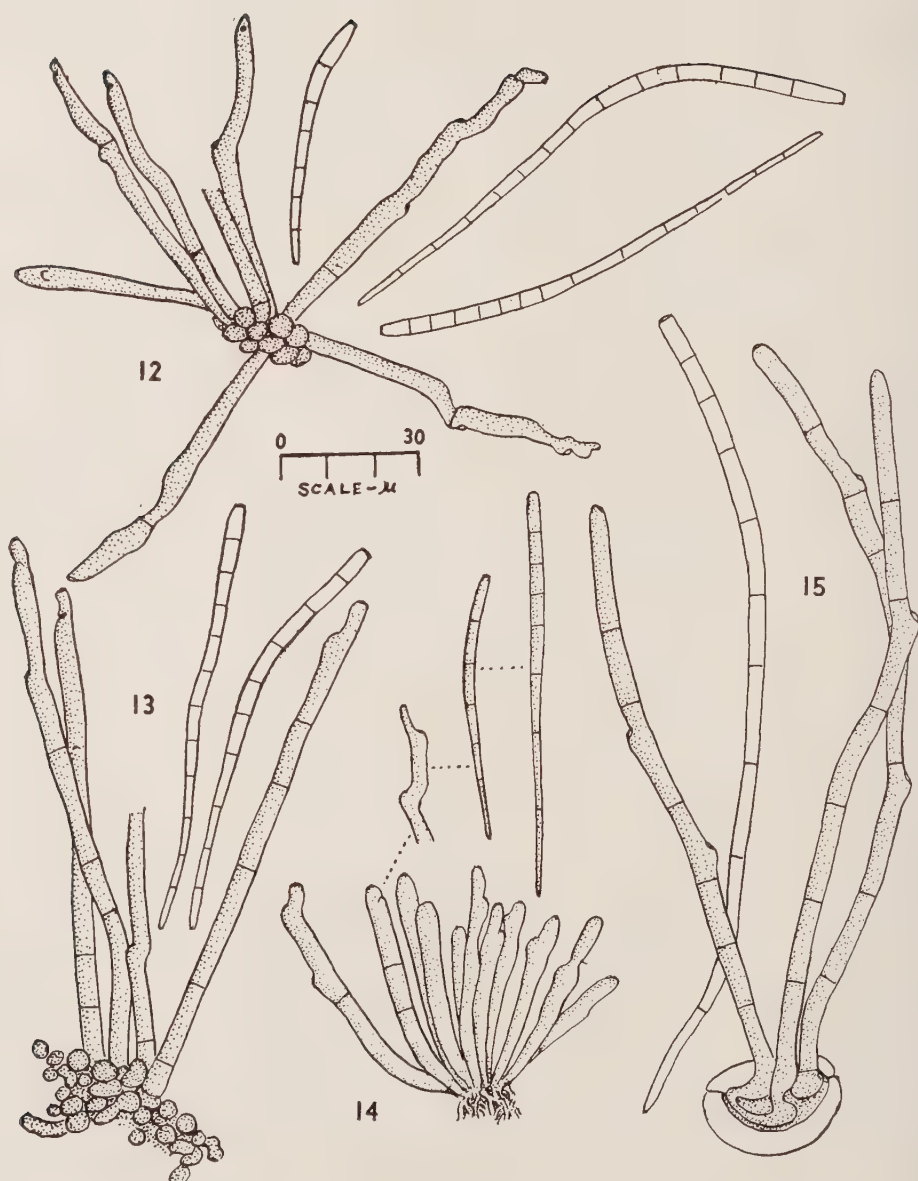
Indefinite yellowish spots on the upper leaf surface; fruiting hypophyllous in sooty effuse layers on orbicular spots (2-5 mm. in diam.) on the lower surface, stroma absent; conidiophores in loose spreading clusters, also arising from procumbent septate olivaceous brown branched hypha, straight or usually curved, denticulate near the apex, subflexuous, olivaceous brown, 3-7 septate,  $57-120 \times 4-5\mu$ ; conidia at first subcylindrical, finally clavate-cylindrical, pale olivaceous, 5-11 septate, base conico-truncate,  $57-101 \times 3.5-5.0\mu$ .

On *Justicia procumbens*, Szechuan: Chengtu, 1943, L. Ling (Ling 125, type). Differs from *C. consociata* by its lack of a stroma, its longer and somewhat narrower conidiophores of different shape.

#### Cercospora justiciaecola sp. nov.

Fig. 9

Maculis hemisphericis, 3-10 mm. diam., centro sordide albidis, atro-brunneo marginatis; caespitulis amphigenis, plerumque epiphyllis, stroma

FIG. 12. *Cercospora Lingi* sp. nov.FIG. 13. *Cercospora daturicola* Speg.FIG. 14. *Cercospora Fagopyri* Nakata et TakimotoFIG. 15. *Cercospora Dahliae* Hara

16–31  $\mu$  diam.; conidiophoris laxe fasciculatis, subflexuosis, geniculatis, 5–6 septatis, olivaceo-brunneis, 96–134  $\times$  5–6  $\mu$ ; conidiis acicularo-obclavatis, subhyalinis, 6–17 septatis, 54–154  $\times$  3–4  $\mu$ .

Spots along the edge of the leaf, hemispherical, 3–10 mm. in diameter, ashy center with dark brown border, in turn surrounded by a yellowish zone; fruiting amphigenous, mostly epiphyllous, stroma present, 16–31  $\mu$  in diameter; conidiophores in loose spreading fascicles, subflexuous and geniculate, 5–6 septate, olivaceous brown, 96–134  $\times$  5–6  $\mu$ , spore scars evident, about 3  $\mu$  wide; conidia acicular-obclavate, 6–17 septate, subconico-truncate at base, subhyaline, 54–154  $\times$  3–4  $\mu$ .

On *Justicia* sp., Szechuan: Chengtu, Oct. 15, 1944, H. C. Liu, type.

#### CERCOSPORA KAKI Ell. et Ev.

On *Diospyrus lotus*, Yunnan: Kaiyuan, Aug. 23, 1939, C. C. Cheo, 5947; Chengkung, Oct. 1938, C. C. Cheo, 6107; Hwaning, Aug. 20, 1938, S. T. Chao, 5960; Chengkiang, Aug. 1939, C. H. Hung, 6335. *D. Kaki*, Yunnan: Mengtze, Aug. 18, 1938, T. H. Wang, 4783; Kaiyuan, Aug. 1939, C. C. Cheo, 5948; Chengkung, Oct. 1939, K. T. King, 5937.

#### *Cercospora Lingi* sp. nov.

Fig. 12

Maculis angulosis v. irregularibus, saepe confluentibus, sordide griseis, definitis, zona indeterminata purpurea cinctis, 1–3 mm. latis; caespitulis amphigenis, stroma nulla; conidiophoris laxe fasciculatis (2–12), rectis, geniculatis, ad apicem denticulatis, interdum subflexuosis, simplicibus, 0–5 septatis, brunneis, 63–123  $\times$  4.3–5.7  $\mu$ ; conidiis acicularis, rectis v. curvulis, 8–15 septatis, hyalinis, 66–157  $\times$  3–4  $\mu$ .

Spots angular, often confluent, ashy gray, definite, surrounded with an indefinite purple zone, usually along the edge of the leaf, 1–3 mm. wide; fruiting amphigenous, stroma absent; conidiophores in loose fascicles of 2 to 12, straight or geniculate, denticulate near the apex, sometimes slightly flexuous, not branched, 0–5 septate, brown, 63–123  $\times$  4.3–5.7  $\mu$ , spore scars conspicuous, 2–3  $\mu$  wide; conidia acicular with truncate base, straight or usually more or less curved, 8–15 septate, hyaline, 66–157  $\times$  3–4  $\mu$ .

On *Oenothera* sp., Szechuan: Chengtu, Nov. 10, 1941, L. Ling (Ling 116, type). Differs from *C. Oenotherae-sinuatae* in the acicular-obclavate conidia and slightly flexuous conidiophores; from *C. Oenotherae* in the wider conidia and conidiophores.

#### CERCOSPORA MEGALOPOTAMICA Speg.

Definite spots, orbicular, surrounded with an indefinite dark brown zone, 1–4 mm. in diameter; fruiting hypophyllous, stroma small, 20–29  $\mu$  in diameter; conidiophores densely clustered, slightly curved, subflexuous,

subequal in width, 0-1 septate, not branched, olivaceous brown,  $20-100 \times 3.5-5.7\mu$ , spore scars about  $3\mu$  wide; conidia at first abruptly obclavate, becoming acicular with truncate base, subhyaline, 5-13 septate, more or less curved, not constricted at septum,  $49-129 \times 3.6-4.3\mu$ .

On *Bidens pilosa*, Yunnan: Wenshan, Aug. 11, 1938, T. H. Wang and S. T. Chao, 4794. Szechuan: Chengtu, Dec. 1940, L. Ling; 1943, L. Ling (Ling 127). This form is closer to *C. megalopotamica* to which the above collections are tentatively referred.

#### CERCOSPORA MELIAE Ell. et Ev.

On *Melia Azedarach*, Yunnan: Wenshan, Aug. 11, 1938, T. H. Wang and S. T. Chao, 5981. Fukien: Yungan, Oct. 10, 1940, W. F. Chiu, 7512. On further study of additional collections the conidiophore proves to be quite variable in length. *C. subsessilis* Syd. seems to be identical with *C. Meliae*.

#### CERCOSPORA MELONGENAE Welles

Spots orbicular, 2-10 mm. in diameter, brownish gray with dark brown border, often indistinctly concentric, sometimes with an ashy center; fruiting amphigenous, stroma  $31-75\mu$  in diameter; conidiophores densely fasciculate, straight or flexuous, equal in width, 0-2 septate, usually non-septate, olivaceous brown,  $17-35 \times 3.5\mu$ , not branched, spore scars minute; conidia subcylindrical becoming clavate-cylindrical, base conico-truncate or truncate, pale olivaceous, 3-8 septate,  $33-89 \times 4.3-5.3\mu$ .

On *Solanum Melongena*, Yunnan: Kunming, Aug. 1938, C. C. Cheo, 5982. Kansu: Langchow, Aug. 27, 1941, W. N. Siang (Siang 143). The spores are pale olivaceous, not hyaline as described in the original diagnosis, and narrower.

#### CERCOSPORA NASTURTII Pass.

Orbicular brownish spots, 1-2 mm. in diameter, becoming whitish in the center, margin not raised; fruiting amphigenous, mostly epiphyllous, scattered, without or with a poorly developed pallid colored stroma ( $17-29\mu$  in diam.); conidiophores loosely tufted, straight, often geniculate, flexuous, olivaceous brown, tapering near the apex, truncate at the tip, 1-4 septate,  $34-91 \times 3.6-4.3\mu$ , spore scars conspicuous, 2-3  $\mu$  wide; conidia acicular, truncate at base, usually straight or slightly curved, 5-13 septate, hyaline,  $66-141 \times 3.0-3.6\mu$ .

On *Rorippa sinapis* (*Nasturtium* s.), Yunnan: Kunming, July 30, 1945, F. L. Tai, 8557.

#### CERCOSPORA PACHYDERMA Syd.

Indefinite circular yellow spots on the upper surface, 4-5 mm. in diameter; fruiting hypophyllous, effuse, sooty, stroma absent; conidiophores in

dense fascicles, usually straight, occasionally slightly curved, simple or branched, 2-6 septate, geniculate, subequal in width, slightly tapering near the apex, olivaceous brown,  $89-167 \times 6.0-6.4\mu$ , spore scars conspicuous, about  $2\mu$  wide, sometimes shouldered; conidia at first subcylindrical, becoming obclavate with conico-truncate base, usually curved, indistinctly 3-4 septate,  $50-129 \times 4-6\mu$ , pale olivaceous.

On *Dioscorea yunnanensis*, Yunnan: Kunming, July 31, 1942, F. L. Tai, 8518. *D. subclava*, Yunnan: Kunming, Sept. 4, 1942, F. L. Tai, 8519.

CERCOSPORA PERSONATA (B. et C.) Ell.

On *Arachis hypogaea*, Yunnan: Mengtze, Dec. 1938, T. F. Yu, 5987; Pinchuan, Sept. 2, 1939, C. C. Cheo, 5925. Kwangtung: Canton, July 1938, C. H. Hung, 6321. Kwangsi: Liuchow, Aug. 1, 1939, T. C. Loh, 5989.

**Cercospora Pileae** sp. nov.

Fig. 3

Maculis flavidis indistinctis; caespitulis hypophyllis, effusis, velutinis, stroma nulla; conidiophoris laxe fasciculatis, lenissime curvulis, undulatis, brunneo-olivaceis, 2-5 septatis,  $63-100 \times 4-5\mu$ ; conidiis subcylindraceutis, lenissime curvulis, 5-8 septatis, pallide olivaceis,  $34-104 \times 4.0-4.5\mu$ .

Indefinite yellowish spots on the upper surface; fruiting hypophyllous, forming a sooty layer, stroma absent; conidiophores loosely fasciculate, slightly curved, undulating, brownish olivaceous,  $63-100 \times 4-5\mu$ , 2-5 septate, spore scars not conspicuous; conidia subcylindrical, subconico-truncate at base, slightly curved, often enlarged near the middle, 5-8 septate, pale olivaceous,  $54-104 \times 4.0-4.5\mu$ .

On *Pilea* sp. (Urticaceae), Szechuan: Chengtu, Sept. 9, 1941, L. Ling, 8524, type.

CERCOSPORA PISI-SATIVI Stevenson<sup>5</sup>

Fig. 7

Spots orbicular, oblong or irregular, center whitish with raised brown or dark brown border, sometimes surrounded with dark concentric rings and in turn an indefinite yellow zone, 1-1.5 mm. wide; fruiting amphigenous, stroma absent; conidiophores in loose fascicles of 3 to 5, straight or flexuous subgeniculate, denticulate near the apex, 2-4 septate, often constricted at septum, brown,  $69-114 \times 5-6\mu$ , spore scars conspicuous, shouldered,  $3-7\mu$  wide; conidia acicular-obclavate, with conico-truncate or truncate base, 4-18 septate, hyaline,  $50-103 \times 3.6-4.3\mu$ .

<sup>5</sup> In the original diagnosis (Ann. Rept. Insular Exp. Sta. Puerto Rico, 1917-1918, p. 138 1919) the name of the fungus is "*Cercospora Pisi-sativae*."

On *Pisum sativum*, Szechuan: Chengtu, Dec. 15, 1937, L. Ling (Ling 103).

CERCOSPORA PUERARICOLA Yamamoto

On *Pueraria Thunbergiana*, Kwangtung: Canton, July 1938, L. T. Lin, 5675.

CERCOSPORA PUNICAE P. Henn.

On *Punica granatum*, Yunnan: Kaiyuan, Aug. 5, 1939, C. C. Cheo, 5972; Dec. 16, 1938, T. F. Yu. 5965.

CERCOSPORA RICINELLA Sacc.

Spots distributed all over the leaf surface, angularly orbicular, brown with a whitish center, 2-6 mm. in diameter, with a band of dark brown indefinite border; fruiting amphigenous, stroma 31-60 $\mu$  in diameter; conidiophores densely fasciculate, not branched, straight or somewhat flexuous, 0-1 septate, usually tapering towards the apex, 24-66 $\times$ 4.3-7.0 $\mu$ , olivaceous brown, spore scar conspicuous, 3-4 $\mu$  wide; conidia acicular-obclavate or obclavate, hyaline, 3-10 septate, subconico-truncate at base, 60-123 $\times$ 3.6-4.3 $\mu$ .

On *Ricinus communis*, Yunnan: Tachwang, Aug. 1939, C. C. Cheo, 5951; Wenshan, Aug. 11, 1938, T. H. Wang and S. T. Chao, 5979.

CERCOSPORA RIGOSPORA Atk.

On *Solanum nigrum*, Yunnan: Kunming, Oct. 1944, F. L. Tai, 8556. Fruiting hypophyllous, effuse; conidiophores densely fasciculate; conidia mostly cylindrical with conico-truncate base.

CERCOSPORA SAGITTARIAE E. et K.

Spots zonate, roundish with brownish center and a band of indefinite dark brown margin, confluent, 3-12 mm. in diameter; fruiting amphigenous, stroma present, 25-62 $\mu$  in diameter; conidiophores loosely fasciculate, straight or more or less curved, zigzag at the upper part, truncate at the tip, olivaceous brown, 1-8 septate, 70-200 $\times$ 4-6 $\mu$ , spore scars conspicuous, about 2 $\mu$  wide; conidia subcylindrical or clavate-cylindrical, conico-truncate or truncate at base, hyaline, not constricted at septum, more or less curved, 63-167 $\times$ 3.6-5.4 $\mu$ , 8-13 septate.

On *Sagittaria sagittifolia*, Yunnan: Kaiyuan, Aug. 4, 1938, S. T. Chao and T. H. Wang, 5956.

**Cercospora sapindicola** sp. nov.

Fig. 10

Maculis sordide albidis, initio angulosis demum indistinctis, irregularibus, confluentibus; caespitulis hypophyllis, stroma 25-44 $\mu$  lata; conidio-

phoris modice v. dense fasciculatis, subflexuosis, interdum geniculatis, undulatis, 0-3 septatis, olivaceo-brunneis,  $53-113 \times 4-6\mu$ ; conidiis initio obclavatis demum subcylindratis, subhyalinis, 4-21 indistincte septatis,  $47-157 \times 4.0-4.3\mu$ .

Spots at first angular, finally becoming confluent and large, indefinite, irregular, dirty white, usually along the edge of the leaf; fruiting hypophyllous, stroma present,  $25-44\mu$  in diameter; conidiophores moderately to densely fasciculate, subflexuous, occasionally geniculate, undulating, 0-3 septate, olivaceous brown,  $53-113 \times 4-6\mu$ , spore scars conspicuous, shouldered, about  $4\mu$  wide; conidia obclavate becoming subcylindrical, with subconico-truncate base, subhyaline, 4-21 indistinctly septate,  $47-157 \times 4.0-4.3\mu$ .

On *Sapindus mukorasis*, Szechuan: Chengtu, Dec. 1, 1939, L. Ling (Ling 207, type).

#### CERCOSPORA SESAMI Zim.

Pale brown angular spots, 1.5-2 mm. wide; fruiting epiphyllous, stroma  $18-31\mu$  in diameter; conidiophores in loose fascicles of 2 or 5, straight or slightly geniculate, subdenticulate at apex, olivaceous brown, paler at apex, 1-3 septate,  $56-86 \times 4.3-5.7\mu$ , spore scars evident; conidia acicular-obclavate, subtruncate at base, usually straight, hyaline, 7-10 indistinctly septate,  $59-129 \times 2.7-4.3\mu$ .

On *Sesamum orientale*, Yunnan: Hwaning, Aug. 20, 1938, S. T. Chao, 5962. Kwangsi: Liuchow, Oct. 9, 1939, T. H. Lo (Hwang 309).

#### CERCOSPORA SOJINA Hara

Spots on pods brownish black, orbicular or irregular, surrounded with a zone of brown, 1.5-11 mm. in diameter; stroma  $50-62\mu$  wide; conidiophores in dense fascicles, usually straight, subequal in width, 2-4 septate, rarely constricted at septum, not branched, olivaceous brown,  $73-139 \times 4.3-5.3\mu$ , spore scars conspicuous, conidia at first subcylindrical, becoming acicular-obclavate, subconico-truncate or truncate at base, 7-12 septate, hyaline,  $46-157 \times 3.6-5.0\mu$ , straight or curved.

On pods of *Glycine hispida*, Yunnan: Kunming, Sept. 14, 1941, F. L. Tai, 7457.

The name, *C. daizu*, is antedated by *C. soja* Hara. This species was first described by K. Hara in 1915 as *C. soja*. Five years later Miura again described it as *C. daizu*. The spores of the Chinese forms are as a rule narrower than those reported elsewhere. The border of the spot on pods is not raised. *Cercopora Kikuchii* Mats. et Tom. is probably the same fungus.

#### CERCOSPORA SOLANACEA Sacc. et Berl.

Spots orbicular or irregular, somewhat angular, dark brown, indefinite, finally with an ashy center and a dark brown border, 2-4 mm. in diameter;

fruiting epiphyllous, stroma present,  $40-86\mu$  in diameter; conidiophores in dense fascicles, straight or curved, subflexuous, sub-uniform in width, 0-2 septate, olivaceous,  $26-37 \times 4.0-4.3\mu$ , spore scar not conspicuous; conidia subcylindrical, becoming acicular-obclavate, subhyaline, conico-truncate at base, slightly curved, 2-18 septate,  $63-143 \times 3.6-5.4\mu$ .

On *Solanum verbascifolium*, Yunnan: Merhkiang, Jan. 3, 1939, H. S. Yao, 6469.

**CERCOSPORA SORGI Ell. et Ev.**

On *Sorghum vulgare*, Yunnan: Tachwang, Dec. 18, 1938, T. H. Wang, 5952; Chengkiang, Aug. 1939, C. H. Hung, 6337.

**Cercospora szechuanensis sp. nov.**

Fig. 8

Maculis nullis; caespitulis amphigenis, effusis, velutinis, totam folium occupantibus et cauliculis maculis elongatis insidentibus, stroma  $19-37\mu$  lata; conidiophoris dense fasciculatis, rectis v. plerumque curvatis, subflexuosis, subnodulosis, 2-4 septatis, rarius ramosis, brunneis,  $57-157 \times 4-6\mu$ ; conidia obclavatis, 7-28 septatis, plerumque lenissime curvulis, subhyalinis,  $57-149 \times 3.5-5.0\mu$ .

No definite spots; fruiting amphigenous, effuse on the whole leaf surface in a sooty layer, also on the stem, stroma present,  $19-37\mu$  wide; conidiophores in dense fascicles, usually curved, subflexuous, subnodulous, 2-4 septate, rarely branched, brown,  $57-157 \times 4-6\mu$ , spore scars conspicuous,  $2-3\mu$  wide; conidia obclavate with subconico-truncate base, 7-28 septate, subhyaline, usually slightly curved,  $57-149 \times 3.5-5.0\mu$ .

On *Pisum sativum*, Szechuan: Chengtu, Dec. 1, 1937, L. Ling (Ling 56, type).

**CERCOSPORA TRUNCATA Ell. et Ev.**

Spots angular or irregular in shape, raised from the surrounding areas, yellowish brown (whitish below), becoming white partially or only in the center, 1.5-3.5 mm. wide; fruiting epiphyllous, stroma absent, conidiophores in loose fascicles, straight or geniculate, zigzag at the upper two thirds, rarely branched, 0-4 septate, brownish olivaceous,  $53-113 \times 4-6\mu$ , spore scar conspicuous and shouldered, conidia acicular-obclavate, hyaline with subconico-truncate or truncate base, 2-18 septate,  $66-217 \times 2.9-4.3\mu$ .

On *Vitis Thunbergii*, Szechuan: Chengtu, Nov. 22, 1939, L. Ling.

**Cercospora viburnicola sp. nov.**

Fig. 1

Maculis angulosis, venulis limitatis, initio atro-brunneis, dein centro brunneis, 5-30 mm. longis, 3-7 mm. latis; caespitulis hypophyllis, stroma

26-46 $\mu$  diam.; conidiophoris plerumque dense fasciculatis, simplicibus, 57-110 $\times$ 3.0-3.8 $\mu$ , 0-4 septatis, olivaceous-brunneis, subflexuosis, rectis v. lenissime curvulis; conidiis abrupte obclavatis, olivaceis, 3-4 septatis, plerumque rectis, 26-47 $\times$ 3.6-4.6 $\mu$ .

Dark brown angular spots limited by veins, becoming brown at the center, 5-30 mm. long, 3-7 mm. wide; fruiting hypophyllous, scattered to subgregarious, stroma present, 26-46 $\mu$  in diameter; conidiophores usually densely fasciculate, not branched, subequal in width, subflexuous, straight or slightly curved, olivaceous brown, 0-4 septate, 57-110 $\times$ 3.0-3.8 $\mu$ , spore scars minute; conidia abruptly obclavate, olivaceous, base subconico-truncate, 3-4 septate, usually straight, 26-47 $\times$ 3.6-4.6 $\mu$ .

On *Viburnum cylindricum*, Yunnan: Kunming, July 1938, J. Hsu, 5929, type.

#### CERCOSPORA VIOLAE Sacc.

Spots suborbicular, visible on both sides, definite, whitish with yellowish brown border, somewhat depressed, 0.6-3 mm. in diameter; fruiting amphigenous, stroma absent; conidiophores in loose fascicles, usually straight, nodulose, not branched, 2-8 septate, often slightly constricted at septum, olivaceous brown, 51-133 $\times$ 4-5 $\mu$ , spore scar conspicuous, shouldered, about 2 $\mu$  wide; conidia clavate-cylindrical, subconico-truncate or truncate at base, 4-10 septate, hyaline, 29-136 $\times$ 2.1-3.6 $\mu$ .

On *Viola* sp., Szechuan: Chengtu, Dec. 1943, M. C. Tai (Ling 133).

#### CERCOSPORA VITIS (Lev.) Sacc.

On *Vitis vinifera*, Yunnan: Wenshan, Aug. 11, 1938, T. H. Wang and S. T. Chao, 5957.

#### CERCOSPORA ZINNIAE Ell. et Martin

Spots irregular or angular, gray or white center with a purplish black or dark brown indefinite border, sometimes confluent, 2-4 mm. in diameter; fruiting amphigenous, stroma present, 26-43 $\mu$  in diameter; conidiophores in dense fascicles, straight or tortuously curved, gibbous, subflexuous, denticulate at the apex, not branched, brown, 49-103 $\times$ 4.0-4.6 $\mu$ , 0-3 septate, spore scar conspicuous, shouldered, about 3 $\mu$  wide; conidia acicular-obclavate, hyaline, usually straight, base subconico-truncate, 5-16 septate, 64-149 $\times$ 3.5-5.0 $\mu$ .

On *Zinnia elegans*, Yunnan: Kunming, Dec. 1939, K. T. King, 5933; Puerh, Jan. 15, 1939, H. S. Yao, 6880. *C. atricincta* Heald et Wolf seems to be the same although the conidia were described as dilute brown in color.

#### CERCOSPORA ZONATA Winter

Spots orbicular, 0.5-0.7 mm. in diameter, zonate, grayish brown alternate with dark purplish brown, border raised, brownish purple; fruit-

ing amphigenous, mainly epiphyllous, stroma small,  $17-29\mu$  in diameter; conidiophores usually densely fasciculate, straight or more or less curved, undulating, often sharply attenuated at the apex, usually wider at the base, not branched, 0-1 septate, olivaceous brown,  $23-89 \times 4-6.4\mu$ , spore scar inconspicuous; conidia cylindrical-clavate or acicular-obclavate with conico-truncate base, 4-10 septate, subhyaline, slightly curved,  $52-124 \times 3.5-5.7\mu$ .

On *Vicia Faba*, Kiangsu: Nanking, Spring 1926, F. L. Tai. *C. Fabae* Fautr. seems to be synonymous with *C. zonata*.

## Studies in the Gasteromycetes XVII. Two Interesting Species from Argentina

W. H. LONG<sup>1</sup>

In studying the *Gasteromycetes* of the Spegazzini herbarium, made available through the courtesy of the Curator, Professor Juan C. Lindquist, two species in particular were found for which amended descriptions and revised taxonomic treatment are in order.

### TYLOSTOMA ARGENTINENSE Speg.

This species, described by Spegazzini in 1912, was illustrated by him as here reproduced (Fig. 1). The type material has suffered much in the en-



FIG. 1. *Schizostoma argentinense*. The type collection after Spegazzini.  $\times \frac{1}{2}$ .



FIG. 2. *Schizostoma argentinense*. The type collection in its present condition.  $\times \frac{1}{2}$ .

suing years and now consists of only one complete plant broken in two, a second, with stem and columella only, and a few fragments of stems, peridia, and gleba (Fig. 2). It has been possible, however, to ascertain that the plant should more properly be referred to the genus *Schizostoma*. The species resembles *S. laceratum* var. *nigrum* Ahmad in its blackish gleba, but is otherwise distinct and is likewise clearly distinguishable from previously named species in the genus, *S. laceratum* Ehr. and *S. mundkuri* Ahmad.

<sup>1</sup> Deceased December 10, 1947. The paper has been rewritten from Dr. Long's preliminary draft by John A. Stevenson, Bureau of Plant Industry, Beltsville, Maryland.

**Schizostoma argentinense** (Speg.) comb. nov.

*Tylostoma argentinense* Speg. Anal. Mus. Nac. Buenos Aires 23: 12-14. 1912.

*Sporophore* consisting of pseudovolva, stipe and sporocarp. *Pseudovolva* about 5 mm. in height, clasping the stipe and surrounded by a dirt encrusted mass of hyphae about 10 mm. thick. Stipe firmly attached in a shallow socket at the base of the sporophore, slightly enlarged upward, 12-15 cm. long, 5 mm. thick at lower end, 5-7 mm. above, not scaly nor fibrillose, hollow, striate above, walls 1 mm. thick, wood brown in age, with no evidence of rhizomorphs. *Sporocarp* subglobose, 10×18 mm., firmly attached to the stipe apex which is enlarged and extends into the glebal cavity to form a knob-like columella. *Exoperidium* a sand encrusted layer, completely deciduous at maturity and with no peridial sheath in evidence. *Endoperidium* smooth, membranous, chestnut brown. *Mouth* indefinite, with stellate dehiscence, and brittle lips when dry as in *S. mundkuri*. *Collar* definite, lacinate, slightly pendent around the stipe. *Gleba* blackish brown to black. *Capillitium* chestnut brown, fragmented, more or less flaccid, non-septate, ends rounded, sparingly branched, thicker than the spores (7-14 $\mu$  in diameter), with short knobs along sides. *Spores* subglobose to oval, uni-guttulate, walls thick, some apiculate, 4-6 $\mu$  in diameter. *Epi-spore* smooth, chestnut brown.

In rocky soil, near Catamarca, Argentina, C. Spegazzini, April 1910, No. 13378.

**BROOMEIA CONGREGATA** Berk. var. **ARGENTINENSIS** Speg. Anal. Mus. Nac. Hist. Nat. Buenos Aires 23: 15-16. 1912.

Spegazzini in setting up his variety of *B. congregata* stated that it differed from Berkeley's type in its conspicuously smaller and verruculose rather than reticulate spores. Berkeley in his original description (London Jour. Bot. 1844: 193. 1844), however, describes and illustrates the spores as echinulate. Fischer (Engler and Prantl, 2nd ed., 7a: 67-68. 1933) does likewise.

Lloyd (Myc. Writ. 6: 918. 1919) considers the Spegazzini variety synonymous with *Diplocystis wrightii*, stating "Spegazzini has probably misrecorded it from Argentina as a variety of *B. congregata*," and later adds "not known to me, but the odds are a hundred to one that it is *D. wrightii*."

The genera *Diplocystis* and *Broomeia* are similar in some respects and have been often confused. The former, however, differs fundamentally from the latter in that each of the sporophores making up the compound fruiting body has its own exoperidium while in *Broomeia* the entire mass of sporophores is covered originally by a universal exoperidium. A comparison of the Argentina specimen (Fig. 5) with that of Lloyd's illustration (Fig. 3) of *Diplocystis wrightii* demonstrates clearly that it cannot be referred to

this genus. On the other hand it is readily referable to *Broomeia congregata* (Fig. 4) and microscopic studies, particularly of the spores, have failed to indicate any reasons for maintaining it as a variety. An emended description of the species based on Spegazzini's specimen follows.

*Sporocarps* (peridia) few to numerous with bases imbedded in subfleshy

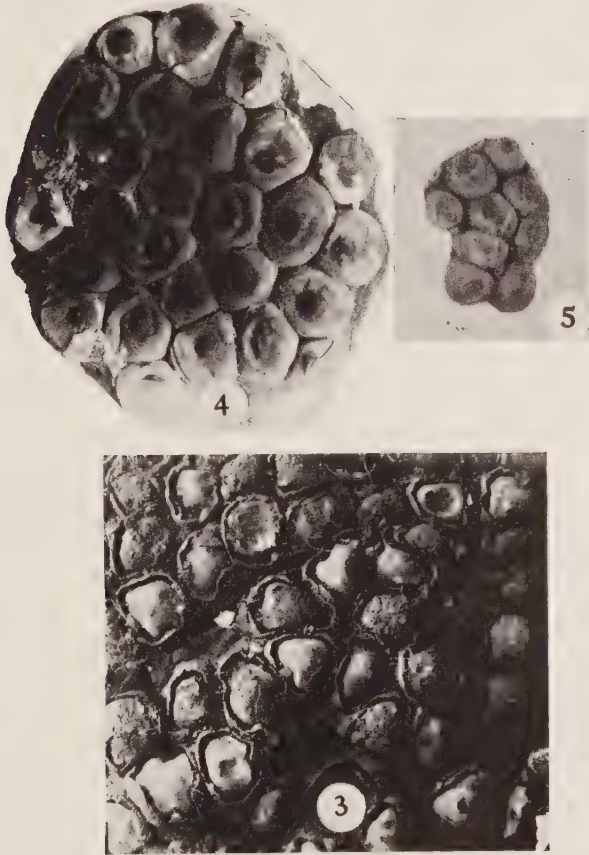


FIG. 3. *Diplocystis wrightii*. After C. G. Lloyd. Slightly enlarged.

FIG. 4. *Broomeia congregata*. After C. G. Lloyd. Slightly enlarged.

FIG. 5. *Broomeia congregata*. The Spegazzini specimen.  $\times 1$ .

basal stroma, subglobose, or compressed laterally, 4–8 mm. high, 5–8 mm. diameter. *Exoperidium* tough, thin, snuff brown to walnut brown. *Mouth* indistinct, with central umbo. *Gleba* walnut brown. *Columella* none. *Capillitium* parietal, brown to nearly hyaline, undulate, simple, smooth, 5–8 $\mu$  diameter, with lumen medium to narrow. *Spores* globose, uniguttulate, 5–7 $\mu$  in diameter, densely echinulate.

On dead joints of *Opuntia* on ground, Piedra Blanca, near Catamarca, Argentina, Nov. 1909, C. Spegazzini, No. 13361.

# Studies in the Gasteromycetes XVIII. The Phalloids of the Southwestern United States

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(*Albuquerque, New Mexico and Safford, Arizona*)

For a number of years we have been collecting specimens and information on the species of the order Phallales which occur in Arizona, New Mexico, and Texas. Our data are recorded in this paper.

## Order PHALLALES

Young sporophore egg-like, covered by a tough peridium which ruptures irregularly at maturity and usually remains as a basal volva. *Gleba* greenish black, slimy, foetid when mature, usually borne on a more or less elongated stipe. *Spores* smooth, elliptical, or cylindrical. The order in our region is divided into two families, *Clathraceae* and *Phallaceae*.

CLATHRACEAE Corda emend. E. Fischer in Engler & Prantl, Die Nat. Pflfam. Teil 1, Abt. 1\*\*: 280. 1900.

*Sporocarp* subglobose to pyriform, or more or less elongated. *Stipe* present or absent. *Glebiferous* part of pileus, latticed or consisting of separate arms, the spore mass seated on the stems or upon some modified part thereof. The gelatinous contents of the volva broken up into areas by plates of intermediate tissue, corresponding to the arms of the pileus.

### KEY TO THE GENERA OF THE CLATHRACEAE

Stipe ending in 5-8 simple arms. . . . . *Lysurus*  
Stipe ending in a spherical network. . . . . *Simblum*  
Stipe composed of simple columns united at the apex but free at the base. Columns chambered, smooth or rugose, gleba bearing on the inner surface. . . . . *Linderiella*

LYSURUS Fries, Syst. Myc. 2: 285. 1822.

*Aseroephallus* Lepr. & Mont. Ann. Sci. Nat. Ser. III. 4: 360. 1845.

*Pharus* Petch, Ann. Bot. Gard. Perideniya 7: 59. 1919.

*Mycopharus* Petch, Trans. Brit. Myc. Soc. 10: 281. 1926.

Young sporophore (egg stage), subglobose, when mature and elongated, having volva stem, and pileus. *Stipe* hollow, cylindrical, usually enlarged upward. *Pileus* having 5-8 simple arms which bear the gleba on their outer surface.

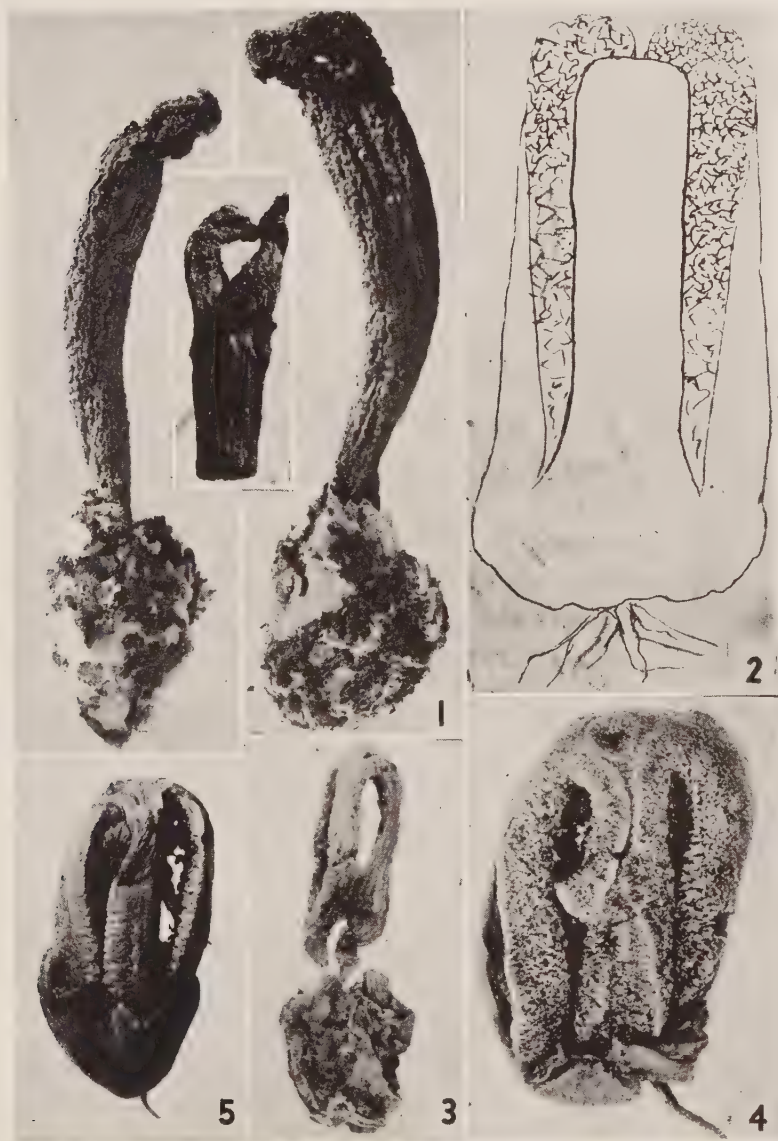
1. LYSURUS GARDNERI Berk. London Jour. Bot. 5: 535. 1846.

*Lysurus texensis* Ell. ex Long Myc. 9: 273-274. 1917.

Fig. 1

*Sporophore* when young (egg stage) about  $2\frac{1}{2}$  cm. in diameter. *Stipe*

<sup>1</sup> Deceased Dec. 10, 1947.



FIGS. 1-5. Phalloids. 1.—*Lysurus gardneri* from Texas  $\times 1\frac{1}{2}$ . 2.—*Lindieriella columnata*, showing glebal area on inside of arms, from drawing by Mrs. Young. 3.—*L. columnata*, dried plant. 4.—*L. columnata*, after Coker and Couch. 5.—*L. columnata* after Lloyd.

hollow, tapering toward base, reddish above, much paler below, 7-12 cm. tall by 10-12 mm. thick, crowned by a finger-like pileus. *Walls* of stipe composed of chambers two layers thick, chambers 2-3 times as long as broad, occasionally opening outwardly but not inwardly, polygonal in cross section, pseudoparenchymatous. *Arms* or fingers of pileus 4-5 in number, at first joined by a thin membrane but later separating, 10-15 mm. long, tapering toward the apex of arm, hollow, orange-red, transversely rugose, with a shallow suture along back of each finger, entirely covered with the gleba on the outer surface, expanding at base where joined to stipe into a thin flat, lobed border, with lobes as many as the arms and lying between their bases. *Gleba* covering and completely hiding the outer surface of arms and borders, having much the appearance of a *Phallus*, but when the gleba deliquesces the true nature of the pileus is seen. *Gleba* foetid and black at maturity. *Spores* elliptical,  $1\frac{1}{2}$ -2 by 4-5  $\mu$ , smooth, hyaline, or tinted.

*Habitat*: In soil near rotting straw stack.

*Distribution*: Texas, Denton, 1907, *W. H. Long*, No. 2000.

Since *Lysurus texensis* described by Ellis was undoubtedly a red species we are placing our plants under Berkeley's earlier name.

LINDERIELLA Cunningham, New Zealand Jour. Sci. and Tech. **23**:  
171 B. 1942.

*Linderia* Cunningham, Proc. Linn. Soc. N.S. Wales **56**: 192. 1931.

This genus differs from *Laternae* in having its gleba on the inner surfaces of the arms in place of only at the apex. This was first named *Linderia* in honor of Dr. David H. Linder, who clarified the position of the gleba, but was later changed by its author to *Linderiella* since *Linderia* was too close to *Lindera* Thunb. a member of the Lauraceae.

2. LINDERIELLA COLUMNATA (Bosc) Cunningham, New Zealand  
Jour. Sci. and Tech. **23**: 171 B. 1942.

*Clathrus columnatus* Bosc Mag. Gesell. Nat. Freunde **5**: 85. 1811.

*Clathrus colonnarius* Lem. Dict. Sci. Nat. **9**: 360. 1817.

*Laternea columnata* Nees & Henay Syst. u. Pilze **2**: 96. 1858.

*Clathrus cancellatus* f. *columnatus* Fischer, Denks. Schweiz. Nat. Gesell. **32**: 56. 1890.

*Linderia columnata* (Bosc) Cunningham, Proc. Linn. Soc. N.S. Wales **56**: 193. 1931.

*Colonnaria columnata* (Bosc) E. Fischer in Engler and Prantl, Pflanzenfam. **7a**: 84. 1933.

Figs. 2-5

*Sporophore* when young (egg stage) subglobose, when mature and elongated having stipe, gleba, and volva. *Volva* opening apically, remaining at base. *Stipe* consisting of 3-4 vertical arms or columns 3-4 cm. long, separate below but joined together at the apex. *Columns* reddish to reddish yellow. *Gleba* on the inner surface of the arms, but not suspended from the apex, odor usually very foetid.

*Habitat*: in rich soil, usually solitary.

*Distribution*: Texas, Houston, March 1877 and July 1878, Mrs. M. J. Young, in Myc. Coll. Bur. Pl. Ind. under the name *Clathrus triscapus*: Jan. 18, 1917, George L. Fisher, Texas Fungi No. 2, in Long Herb. no. 6270.

Mrs. Young sent drawings and descriptions of her collections; commenting as follows on the fresh plants, "Volva globose, white wrinkled, about  $1\frac{1}{4}$  of an inch in diameter, closely enveloping the hymenial structure which is divided vertically into 3 parts like the carpels of an orange. Each of these divisions or arms prolonged above into a flat ribbon-like strip about  $\frac{1}{3}$  of an inch wide by 2 inches long, pale flesh color, nearly smooth outside except where the fragments of the volva remain attached, but very rough on the inner surface almost like a broken honeycomb (Fig. 2), about the color of raw beef and thickly covered with a dirty olive colored slime containing the minute (.002') oblong, nearly hyaline spores. A main stipe is entirely wanting, the hymenial structure being divided down to the very base of the volva, the inner surface being roughened like that of the ribbon. The volva has a few white rootlets at its base. Odor not strongly scented, but has a rather disagreeable smell." The 2 plants collected by Mrs. Young had only 3 arms but the collection by Fisher made some 30 years later has 4 arms. This plant was called by the natives of Florida "Dead men's fingers" due to their odor and shape. The Fisher collection shows the gleba on the dried plant extending down on the inside of the arms some 2 cm., thereby corresponding with the specimens described and figured by Mrs. Young in 1877.

Linder (5) showed that *Laternea* was erected on a species having simple columns which have an angular subovate structure appended to the juncture of the apices of the columns and carrying the gleba beneath this apex. Some other columnar species carry the gleba on the modified inner surface of the columns and hence do not belong to *Laternea*. Linder (l.c.) suggested that those species that do not carry the gleba at the apex as in *Laternea triscapa* be treated as either species of *Clathrus* or under *Colonnaria* of Rafinesque (9) as used by Fischer (3, pp. 84-85). This would make *Linderiella* a synonym of *Colonnaria* which seems to us a very absurd proposition since Rafinesque did not describe or illustrate his "genus." His sole contribution being "*Colonnaria (urceolata, truncata* etc.), divided into four pillars united at the top, which bears the seeds on the margin. Found in Penn." Cunningham (l.c.) says "It is mere guess work to assume that he was dealing with any of the species under consideration, or in fact with any fungus, consequently Fischer's treatment cannot be accepted." It seems incredible to us that scientists would accept such data as the above and then proceed to assign species under such an indefinite unknown genus. Lloyd (6) aptly calls them "Rafinesque ravings."

The genus *Colonnaria* was defined by Fischer (l.c.) as follows, "Gleba

a compact mass suspended from the apex of the receptacle, then deliquescent." This statement was pure guess by Fischer and an incorrect one at that as the main species placed by him under *Colonnaria*, is *Clathrus columnatus* and this does not have the gleba suspended from the apex of columns, but according to Linder it (l.c.) is found scattered over the inner surface of the arms or stems.

Moeller (8, pp. 49-57, 146) lists and describes as *Laternea columnata* a plant from his region which according to his description has the gleba suspended from the apex of the arms and hence is not *Linderiella columnata* but is a true *Laternea*.

According to Moeller (l.c.) the plant that he describes as *Laternea columnata* was first described as a new species, *Clathrus brasiliensis*, by Ed. Fischer in 1888, but Moeller transferred it to *Laternea*. Since Moeller's plant, according to his description, is a true *Laternea* with the gleba suspended under the apex of the arms, while the true *C. columnata* has the gleba scattered over the inner surface of the arms, the plant described by him must revert to Fischer's name of *Clathrus brasiliensis* and according to present usage would become ***Laternea brasiliensis*** (Fischer) comb. nov.

*Blumenavia* Moeller and *Linderiella* Cunningham are so close generically that it is very doubtful if the two genera should be kept separate. We are, however, holding to *Linderiella* since we know that our plants belong here and since we have never seen *Blumenavia* we are not qualified to decide on the synonymy of these two genera. Lloyd claims the two are synonymous (6).

SIMBLUM Klotzsch, Hook. Bot. Misc. 2: 164. 1831.

*Dictybole* Atk. Bot. Gaz. 34: 42-43. 1902.

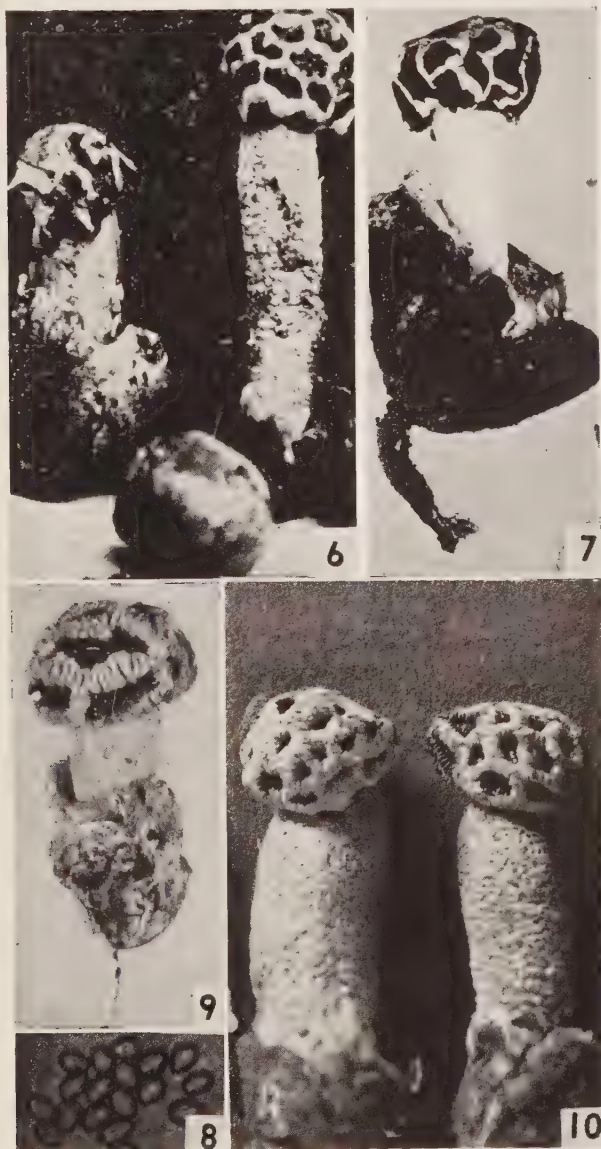
*Stipe* distinct, hollow, having a hollow clathrate structure at its apex within which the gleba is borne.

3. SIMBLUM TEXENSE (Atk. & Long) Long, Jour. Myc. 13: 112-114. 1907.

*Dictybole texense* Atk. & Long, Bot. Gaz. 34: 42-43. 1902.

Figs. 6, 8

*Sporophore* when young (egg stage) depressed-globose to globose-ovate, 1-4 cm. across when mature and elongated having stipe, volva, and pileus. *Volva* circumscissile, upper portion or volva cap borne aloft on the pileus. *Stipe* 4-8 cm. tall by 1-2 cm. thick, cylindrical or tapering slightly toward the base, more or less angular and longitudinally furrowed, hollow, pale yellow. *Walls* of stipe composed of chambers 2-3 layers thick at the middle of the stem, but only 1 layer thick at base, inner layer usually much longer than the others and composed of longitudinal chambers which are many times longer than broad, irregularly polygonal in cross section,



FIGS. 6-10. Phalloids. 6.—*Simblum texense*. 7.—*S. texense* var. *albidum*. 8.—*S. texense*, spores.  $\times 1000$ . 9.—*S. sphaerocephalum*, from New Mexico showing the prominent cross bars of the meshes. 10.—*S. sphaerocephalum*, from Texas.

opening neither inwardly nor outwardly. *Pileus* depressed-globose or often, in the fresh specimens cap-like and usually with the remains of the volva adhering to the apex, composed of more or less isodiametric meshes, the outer row of which is usually free from stipe at its outer and lower margin; meshes very irregular in shape and size from 10–20 in number with 8–10 marginal ones, usual size of each mesh 4–5 mm. across and composed of 4–6 pale yellow bars which are only very faintly transversely rugose or not at all. *Pileus* in the fresh plants always more or less distorted so that the true characters of the plant are difficult to determine. *Veil* none seen. *Gleba* in mass brown, not readily deliquescing, but usually persisting between the bars till the rains and dews wash it off, when it does deliquesce it blackens and has the usual foetid odor of this group; when fresh the gleba and entire plant has a pleasant very pronounced amylacetate odor. *Spores* oval, (Fig. 8) 4–7  $\mu$ , greenish hyaline.

*Habitat*: Solitary, rarely in pairs from a common root, occasionally twin plants from the same egg, in grassy open pastures.

*Distribution*: Texas, Denton, Sept. to Dec. 1902, *W. H. Long*, no. 42; Oct. 10, 1902, no. 2014; Bryan, May 20, 1935, *G. E. Altstatt*, no. 84; Sept.—Dec. 1902, Lloyd Myc. Coll. no. 23095 as *Simblum flavescens*.

This species is unique in the following respects (1)—its agreeable odor so different from the usual phalloid. (2)—its persistent gleba, which in the field rarely deliquesces but dries up and remains on the pileus as a hard brown mass to be finally washed off by rains. (3)—no flies were ever seen to visit them even when the gleba deliquesced and became black and foetid. (4)—the great variability of the pileus as to shape, no two plants being alike especially when elongation occurs in the open field. (5)—its circumscissile volva, on most plants the upper part of the volva is carried up on the top of the pileus and remains there as a persistent cap, usually covering all of the meshes, except the marginal row. This method of rupturing the volva is caused by the eggs having partially dried before the stem elongates and the outer layer of the volva is thus brought into contact with the top of the pileus and adheres to it. It was the abnormal plants in this condition in alcohol on which Atkinson (2) erected his genus *Dictybole*.

The figure which Lloyd (Myc. Writ. 3: 65; fig. 85) labeled *Simblum texense* is not this species but is *S. sphaerocephalum*, evidently a mix up in the labels, as *S. sphaerocephalum* has meshes in its pileus well defined by cross bars or corrugations, or walls of meshes transversely rugose (Fig. 9). This condition is not known to us in *S. texense* or any other species of *Simblum*.

A truly white *Simblum* is a rarity in any country. Occasionally a white or albino plant of a normally red or yellow *Simblum* is found, especially of *S. sphaerocephalum* but consistently white plants of *Simblum* were not known to occur in this country until Long (7) reported one from near

Albuquerque, New Mexico. This white *Simblum* when fresh has a very pronounced amylacetate odor, exactly like the yellow *S. texense* previously described from Texas. The plant has several other characteristics of the yellow Texas species. It was therefore made a variety of this species since there were not sufficient differences to warrant a new species.

4. *SIMBLUM TEXENSE* (Atkinson & Long) Long var. *ALBIDUM* Long, Mycologia 34: 128-131. 1942.

Fig. 7

*Sporophore* when young (egg stage) obovate to turbinate, 2-4 cm. across by 3-5 cm. tall with a strong radicating base, having some roots 5 cm. long, wood brown to buffy brown, originating 1-2 cm. below the surface of the soil, when mature and elongated having volva, stipe, and pileus. *Volva* circumscissile, upper part borne on the apex of the pileus when elongation is in the field, cupulate, inflated, wood brown, furfuraceous with minute hyaline hyphae which bind the grains of sand to its surface. *Stipe* 4-9 cm. tall by 1-1.5 cm. thick, terete or flattened, often fluted or furrowed, white inside and out. Walls composed of 2-3 layers of chambers 1-2 mm. thick. *Chambers* opening either outwardly or inwardly, 1-2 layers of cells thick at top of stipe and 2-3 cells thick at the base, each cell about 2 mm. in diameter by 4 mm. long, cells irregularly polygonal, 4-5 sided. *Pileus* depressed globose 1-2 cm. across by 1-1½ cm. tall, composed of very irregular, more or less isodiametric or oblong meshes, 4-6 mm. in diameter, 12-24 in number, the outer row of meshes usually free from the stipe at its outer and lower margin; bars white, not transversely rugose, consisting of a thin membrane. *Gleba* when fresh grayish olive to buff olive, having a pleasant amylacetate odor, becoming hard and black within 2 hours after plant elongates, not deliquescing, until after rains occur, then becoming foetid. *Spores* subglobose to oval to pyriform, 2.5-3.3 by 4.2-5.6  $\mu$  (average 3-5  $\mu$ ) walls rather thick, hyaline, smooth.

*Habitat*: Solitary in sandy adobe alkaline soil in grassy areas, in semi-arid regions.

*Distribution*: New Mexico, Bernalillo County near Albuquerque, elevation 5000 feet, *W. H. Long*, June 1, 1941, no. 9333; June 9, 1941, no. 9348; Sandoval County 5½ miles west of San Ysidro, on State Highway 44, elevation, 6250 feet, no. 9378.

Fifty of the white plants have been found without any yellow ones intermingled. The differential character of the variety is the consistently white color of the stipe and the bars in the gleba, as well as the fact that the color and surface of the eggs differ. *S. texense* has a yellowish white nearly smooth surface, while the variety is snuff brown, with a furfuraceous surface covered with adhering grains of sand. Fig. 7 illustrates a plant of the vari-

ety collected in the egg stage and placed in a damp chamber until elongation, clearly showing the *Simblum* characters.

5. *SIMBLUM SPHAEROCEPHALUM* Schlecht. *Linnaea* 31: 154. 1862.

*Simblum pilidatum* Ernst, *Grevillea* 6: 119. 1878.

*Simblum rubescens* Gerard, *Bull. Torr. Bot. Club* 7: 8. 1880.

*Simblum rubescens* var. *kansense* Cragin, *Bull. Washburn Coll. Lab. Nat. Hist.* 1: 34. 1885.

Figs. 9-10

*Sporophore* when young (egg stage) subglobose to ovate, 2-3 cm. across by 3-4 cm. tall, originating below the ground surface, when mature and elongated having volva, stipe, and pileus. *Volva* white, solitary with a strong rooting base, dehiscing by irregular flaps at top. *Stipe* geranium pink, 6-11 cm. tall by 1-1½ cm. thick, hollow, cylindrical or slightly tapering toward base, walls 1-2-several chambers thick, the latter many times longer than broad, opening outwardly as pits, but not usually constricted at juncture of pileus. *Pileus* depressed globose to subglobose, scarlet, 1 cm. tall by 2 cm. broad, meshes regular of 4-6 sides, isodiametric, 10-20 in number, each 3-4 mm. across, walls of meshes strongly transversely rugose, left as a hollow network after the gleba dehisces. *Spore* mass foetid, spores oblong 2×4 mu.

*Habitat*: Solitary on lawns at Austin, Texas, and at margins of thickets and in open sandy fields or along ravines in black soil.

*Distribution*: New Mexico, Corona area, Aug. 1940, *D. J. Stouffer*, no. 8750; June 1941, no. 9357, 9399; Sept. 17, 1942, no. 10272; *D. J. Stouffer* & *Jack Porter*, June 1941, no. 9548; Nov. 1941, no. 9856; July 19, 1941, *Jack Porter*, no. 9803; July 16, 1941, no. 9538; Sept. 5, 1941, *Long, Stouffer* & *Porter*, no. 9541; June 1941, *Stouffer* & *Porter*, no. 9548; *Jack Porter*, July 16, 1941, no. 9540; July 1941, no. 9560; July 16, 1941, no. 9540. All of the Corona plants were in rocky grassy areas, or on areas where wind blown sand had nearly covered the native grass plants near the edge of cultivated fields.

Texas, Denton, Dec. 23, 1907, *W. H. Long* in Johnson grass pasture no. 2050; these plants have pores opening outwardly; Dec. 1904 and Nov. 1905, no. 9013; Bryan, Brazos County in lawn, Dec. 1934, *Dr. Walter Ezekiel*, no. 8451.

The New Mexico plants are peculiar in several ways. They have many yellow plants growing side by side with the normal red ones, they have no cells opening outwardly, and they are on an entirely different site from those in Texas. The soil is relatively poor with not much humus or decaying vegetation and yet they came up in large numbers during a wet year. The odor of the spore mass is quite different from any we are familiar with. Even in the old mature spore mass there is a strong odor of rancid bacon

rind rather than the very foetid odor so common to this group. In spite of all these differences we feel that it is *Simblum sphaerocephalum* with a variant here and there in the large number of plants found.

PHALLACEAE Corda, Icones Fungorum 5: 29. 1842.

Peridium of 3 layers, rupturing usually from the apex downward into several lobes exposing the stem and gleba and remaining as a volva at its base, gelatinous contents continuous not breaking up into plates of intermediate tissue. *Sporocarp* free from the volva, with a fusoid to cylindrical hollow stem having one or several layers of chambers; bearing the spore mass on the modified upper segments or on a campanulate pileus attached to the apex. *Indusium* present in one genus. *Basidia* having 4-8 sessile, elliptical, smooth spores.

KEY TO THE GENERA

- 1—Spore mass borne directly on the naked upper part of the stem.....*Mutinus*  
 1—Spore mass on a campanulate pileus.....2  
 2—Pileus of lamellate plates.....*Itajahya*  
 2—Pileus rugulose, papillate or reticulate.....*Phallus*  
 2—Pileus with a prominent indusium or netted veil.....*Dictyophora*

MUTINUS Fries, Summa Veg. Scand. p. 434. 1849.

*Cyanophallus* (Fries) Corda, Icones Fung. 6: 19. 1854.

*Corynites* Berk. & Curt. Trans. Linn. Soc. 21: 151. 1855.

*Egg stage* subglobose to ovate, pinkish white, 1-3 cm. in diameter. *Stipe* distinct, hollow, tip usually perforate. *Volva* sheathing the base. *Spore mass* or gleba greenish black when deliquescing, borne on the upper part of the pointed stipe. *Color* red above and fading downward.

6. *MUTINUS ELEGANS* (Mont.) E. Fisch. in Sacc. Syll. Fung. 7: 13. 1888.

*Corynites elegans* Mont. Syll. Crypt. p. 281. 1856.

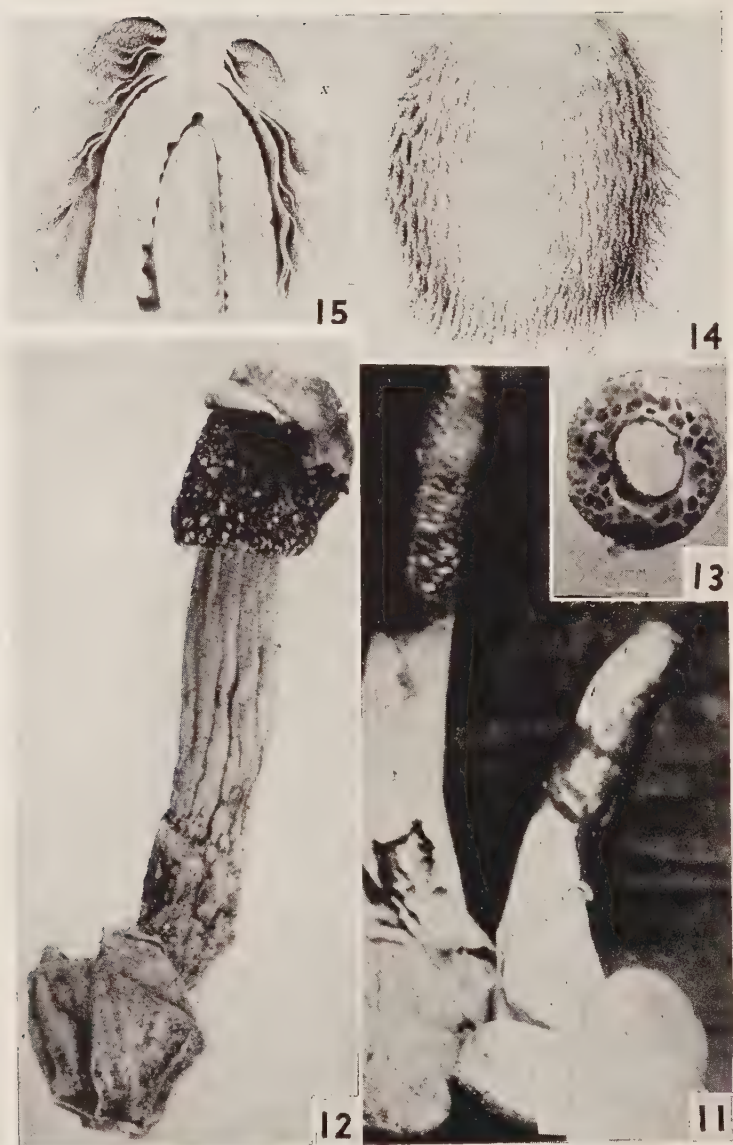
*Corynites curtisii* Berk. Grev. 2: 34. 1873.

*Mutinus curtisii* (Berk.) E. Fisch. in Sacc. Syll. Fung. 7: 13. 1888.

*Mutinus bovinus* Morg. Jour. Cinn. Soc. Nat. Hist. 11: 147. 1889.

Fig. 11

*Young sporophore* (egg stage), white except for the exposed portion which is pinkish brown, ovate to pyriform, 2-3 by 3-4 cm., when mature and elongated with a stipe and a gleba bearing tip. *Volva* white to pinkish at exposed top, subglobose to pyriform, dehiscing by irregular flaps at sheathing base. *Stipe* cylindrical below the gleba, but the gleba bearing part tapering to a point above, 6-12 cm. tall by 1-1½ cm. thick; lower part of stipe orange red, upper 2 cm. a deeper orange. *Gleba* bearing portion flesh color, 4-5 cm. long, conic, perforated. *Glebal* tissue of one layer of cells with walls very thick and open to inside of stipe. *Sterile* portion of



FIGS. 11-15. Phalloids. 11.—*Mutinus elegans*. 12.—*Itajahya galericulata*, dried plant. 13.—*I. galericulata*, cross section of stipe. 14.—*I. galericulata*, showing the peculiar structure remaining after spore removal. 15.—*I. galericulata*, overlapping tramal plates. 14 and 15 after Moeller.

thin walled chambers one or two cells thick. *Spore-mass* very foetid. *Spores* smooth, elliptic, 2-3 by 4-7  $\mu$  in diameter.

*Habitat*: In groups of 4-20 plants in sandy soil near base of rotting *Quercus* stumps.

*Distribution*: Texas: Denton, Nov. and Dec. 1902 *W. H. Long*.

ITAJAHYA A. Moeller, Brasilische Pilzblumen, p. 79. 1895.

*Pileus* campanulate, composed of lamellate plates on which the gleba is borne. *Veil* absent or present in a rudimentary form.

7. ITAJAHYA GALERICULATA A. Moeller, Brasilische Pilzblumen, pp. 79-100 et 148. 1895.

Figs. 12-15

*Albofiella argentina* Speg. Ann. Mus. Nac. Buenos Aires 6: 183. 1899.

*Sporephore* when young (egg stage) ovate to subglobose, 2-3 cm. in diameter by 3-5 cm. tall with a radicating base, originating 5-8 cm. below the surface of the soil, when mature and elongated having volva, stipe, and pileus. *Volva* circumscissile, upper part borne as a cap on top of the pileus when the plants elongate, often covering the entire gleba, white when fresh becoming tilleul buff in age. *Stipe* cylindrical to somewhat fusiform, tapering rapidly to a point inside the volva cup, white when fresh changing to cartridge buff on drying, 4-15 cm. tall (many plants only 4-6 cm. tall) by  $1\frac{1}{2}$ -2 cm. in diameter in the thickest portion (the middle), stem cavity 7-15 mm. wide expanding into a funnel 1-2 cm. wide at top, covered by the calyptra, margin of the funnel spreading over top of gleba as a crenulate white collar on border. *Calyptra* white with dentate edges covering the entire pileus,  $1-2\frac{1}{2}$  cm. in diameter, tough, becoming free from the collar but held in place by the volva cap. *Walls* of stipe thick, tough, composed of isodiametric chambers which open outwardly as small pores, while a few open inwardly, 2-3 chambers thick at the base of stipe, 4-5 in middle and 3-4 chambers thick at top. *Pileus* cylindrical, campanulate,  $1-2\frac{1}{2}$  cm. across by 1-2 cm. tall, flattened on top by the adhering volva cap, often unsymmetrical, one-half being larger than the other, undersurface white, free from stem but often clasping it very tightly. *Veil* thin, membranous, non-perforate, appearing as a white band of tissue on the stem and as a white cup enclosing the base of the stem inside the volva cup. *Gleba* when fresh olive gray to mouse gray, turning black on deliquescing, then moderately foetid, attached to the underside of border and to inside of wall of pileus, formed of lamellate overlapping trama plates which traverse the entire pileus and divide repeatedly, terminating on the outer surface of the gleba as white irregular spots giving the surface a mottled appearance (Fig. 12); when the gleba is carefully washed off, the surface of the pileus resembles a wig (Fig. 14). *Spores*  $1 \times 1.5-2 \mu$  by 3-5.5  $\mu$ , hyaline, smooth.

*Habitat*: Solitary or in groups of 2-4 individuals in sand-clay soil on top of mesquite (*Prosopis juliflora*) sandhill dunes, under the trees and immediately adjacent to the tree trunks (in New Mexico); in mesquite-catclaw flats (*Prosopis-Acacia*) in Arizona and in mesquite-cactus (*Opuntia*) areas (in Texas); in arid or semi-arid regions.

*Distribution*: Arizona, Santa Cruz County, 7 miles north of Nogales on the Nogales-Tucson Highway 89, elevation 3857 ft., *W. H. Long & Victor O. Sandberg*, Nov. 11, 1933, no. 7849; Pima County, 8 miles from Tucson on road to Sabino Canyon, elevation 2400 ft., *W. H. Long and Victor O. Sandberg*, Sept. 22, 1934, no. 8016; Sept. 29, 1934, *W. H. Long*, no. 8382. New Mexico, Doña Ana County, Jornada Experimental Range, elevation 4150 ft., Sept. 8, 1941, *W. H. Long and David J. Stouffer*, no. 9602; Luna County 10 miles west of Deming on Highway 70, elevation 4300 ft., *W. H. Long and David J. Stouffer*, Sept. 12, 1941, no. 9641; Sept. 13, 1941, no. 9656. Texas, Starr County, near Falfurrias, elevation 300 ft., *O. F. Cook*, Sept. 1909.

This plant has a variable habitat. In South America it grows in a wet climate, while in North America it is found in dry semi-arid regions of the southwestern United States. It has also been reported from Argentina by Fries (4) in regions somewhat similar to its habitat in North America.

Ahmad (1) recently stated that *Phallus roseus* Delile was only a rosy form of *Itajahya galericulata*. He bases his conclusions on the fact that although the stems of his plants are usually orange pink or orange buff, white stemmed forms are by no means rare. Too much stress should not be laid on color differences as it may vary in individual plants of the same species found in the same locality. The finding of an occasional white plant in a group of Phalloids is not proof that such albinos are normal, but rather the reverse. We have found white and yellow specimens of *Simblum sphaerocephalum* as noted in this article, but these colors do not prove anything since they are clearly abnormal. In view of the above we think it wise to consider the white *Itajahya* found on this hemisphere *I. galericulata*, since no rosy forms have ever been found among these white plants.

PHALLUS Pers. Syn. Fung. p. 242. 1801.

*Hymenophallus* Nees Syst. Pilze Schw. p. 251. 1817.

*Ithyphallus* (Fries) E. Fischer, Ann. Jard. Bot. Buit. 6: 4. 1886.

*Sporophore* when young (egg stage) subglobose to ovate, stem hollow with a sheathing volva. *Pileus* apical, smooth or reticulate. *Veil* indeterminate or well developed, then not perforate or netted, between pileus and stem, usually inconspicuous, not a true indusium. *Spores* generally black, borne on the outer surface of the pileus, smooth, foetid, elliptical.



FIGS. 16-19. Phalloids. 16.—*Phallus rubicundus*, from New Mexico. 17.—*P. rubicundus*, showing surface markings. 18-19.—*P. iosmos*, from Texas.

8. PHALLUS IOSMOS Berk. in Smith Eng. Fl. 5: 227. 1836.

*Phallus imperialis* Schulzer, in Kalchb. Icones Sel. Hymen. Hung. p. 63. 1877.

*Itthyphallus impudicus* (Pers.) E. Fischer, Versuch einer systemat. p. 43. 1886.

*Phallus purpuratus* Cragin, Bull. Washburn College 1: 34. 1885.

*Phallus impudicus* L. var. *imperialis* (Schulzer) Ulbrich Ber. d. bot. Ges. 50A: 314. 1932.

Figs. 18-19

*Sporophore* when young (egg stage) ovate to irregularly globose, 12 cm. in diameter with a radicing base, originating 5-7 cm. below surface of

soil, mycelium and eggs pink changing to dark purple when injured, when mature and elongated having volva, stipe, and pileus. *Volva* dehiscing apically and irregularly leaving the gleba free and the volva cup at base of stem. *Stipe* cylindrical to fusiform, hollow, white, changing to creamy white in age, 2–20 cm. tall by 2–4 cm. thick. *Walls* of stipe several layers of chambers thick, which open both outward and inwardly as pits, chambers isodiametric, pseudoparenchymatous. *Stipe* perforate or open at apex and joined to the pileus by a broad white collar. *Pileus* conic-campulate, strongly and deeply alveolate-reticulate, white, 3–7 cm. tall by 2–5 cm. broad. *Veil* wanting or when present membranous, floccose, white, beneath the pileus or in bands and patches on stipe or clinging to the stipe inside the volva, attached to and continuous with the inner cup-like portion surrounding the base inside the volva cup. *Gleba* a blackish mass of spores foetid on outer surface of the pileus. *Spores* oblong  $1\frac{1}{2}$  by 4  $\mu$ .

*Habitat*: In rich loose soil in open fields or near margins of thickets, never in well shaded locations.

*Distribution*: Arizona, Crook National Forest Aug. 1934, *D. J. Stouffer*, no. 7973; Prescott National Forest, Sept. 19, 1934, *W. H. Long*, *V. O. Sandberg*, *K. D. Butler* and *D. E. Ellis*, no. 8012; *W. H. Long*, 1935, no. 8032; Prescott, Sept. 23, 1933, *William Stambaugh*, no. 8966. New Mexico, Corona area, Aug. 1940, *D. J. Stouffer*, no. 9133; July 26, 1940, nos. 9517, 8750, 8760; Silver City, 1911, *W. H. Long*, no. 8994; Gallinas Ranger Station Aug. 22–Sept. 18, 1942, *D. J. Stouffer*, no. 10273; Ft. Bayard, 1913, *W. H. Long*, no. 8780. Texas, Denton, Oct. 20, 1902 to Jan. 15, 1903, *W. H. Long*.

This species is more widely distributed in the United States than any other known phalloid. It always has a pink volva and has never been found in this country in the pure white stage, so characteristic of the *Phallus impudicus*, of European countries. We are, therefore, calling our plants *Phallus iosmus*, the known pink form, as this is the oldest name after *Phallus impudicus*.

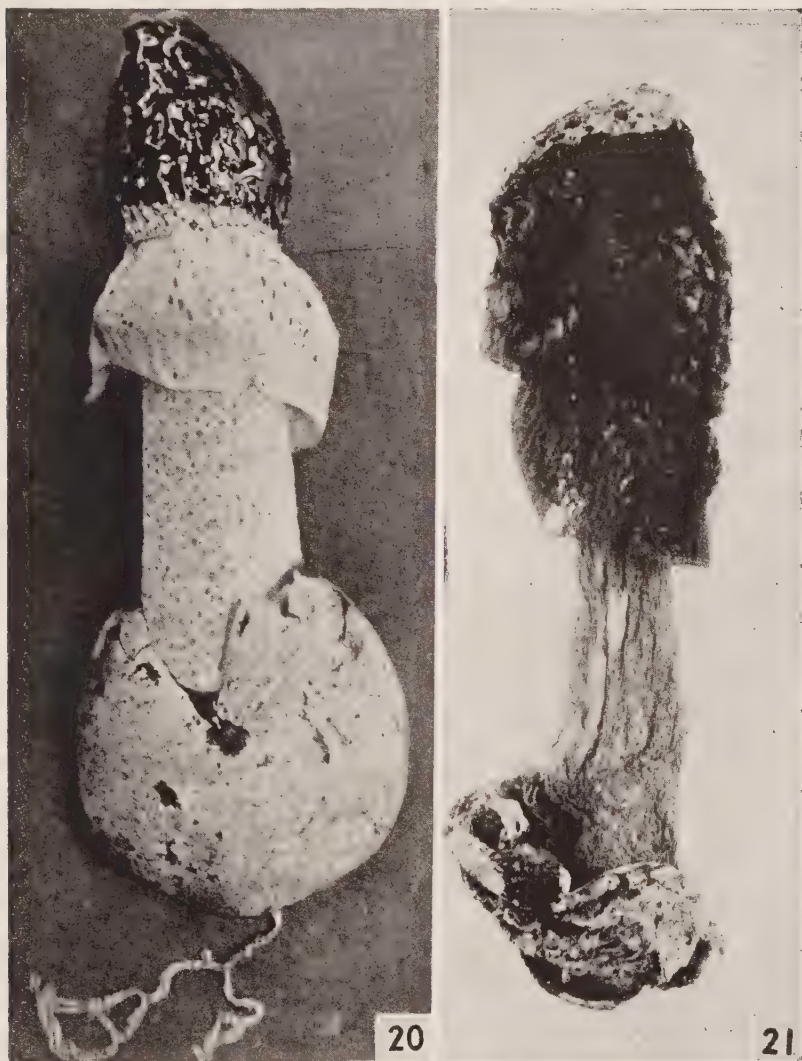
#### 9. PHALLUS RUBICUNDUS (Bosc) Fries, Systema Mycolog. 2: 284. 1822.

*Satyrum rubicundus* Bosc Mag. Ges. Nat. Freunde 5: 86. 1811.

*Ithyphallus rubicundus* (Bosc) E. Fischer, Sacc. Syll. Fung. 7: 11. 1888.

Figs. 16–17

*Sporophore* when young (egg stage) white, subglobose to ovate, 2–3 cm. tall by 1–3 cm. thick, when mature and elongated having volva, stipe and pileus. *Volva* dehiscing apically by splitting at the top of the volva into several lobes, attached to a net work of white rhizomorphs in some cases. *Stipe* cylindrical-fusiform to fusiform, scarlet, 9–15 cm. tall by  $2\frac{1}{2}$  cm. in diameter, walls several chambers thick, which open onto outer and inner surface of the stipe as pits; chambers isodiametric, pseudoparenchymatous.



FIGS. 20-21. Phalloids. 20.—*Dictyophora duplicata*, after Coker and Couch. 21.—*D. duplicata*, from New Mexico.

*Apex* of stem either perforate or imperforate but usually becoming perforate as the plants age due to the scarlet cup covering the apex falling entirely off. *Pileus* joined at apex by a narrow, irregular, scarlet collar or ring, conic, smooth or rugose, scarlet, sometimes extending below the gleba into a narrow sterile border, whose edges are finely crinkled to dentate, pseudoparenchymatous, 1-2 cm. wide by 2-3 cm. tall. *Veil*

wanting or when present, membranous, floccose, white, beneath pileus or in bands or patches on the stipe or clinging to the stipe within the volva as in *P. iosmos*. *Gleba* when fresh isabella color, becoming a dirty yellowish brown when deliquescing, with a very foetid odor. *Spores* oblong,  $2 \times 4$   $\mu$ .

*Habitat*: In lawn and open grassy areas or in old sandy fields near rotting oak stumps or along fences in sandy soil.

*Distribution*: New Mexico, Jornada Experimental Range at roots of *Arundo donax*, Sept. 5, 1941, K. A. Valentine, no. 9612; Albuquerque, Sept. 1–Oct. 10, 1925, W. H. Long, no. 7740. Texas, Austin, April, May, & Nov. 1900, W. H. Long, abundant in groups of 4–6 plants, usually 1 large plant surrounded by eggs of various sizes all attached to a common network of rhizomorphs. The smaller eggs usually produced much smaller plants than the first and central one. The small eggs in these groups often produced plants only  $2\frac{1}{2}$  cm. tall but were perfect copies of their larger companions; Denton, near old rotting oak stumps and along fence rows in sandy soil, Nov. 1902 to Jan. 1903, W. H. Long.

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## Nomenclatural Transfers Among Coccoid Algae

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During the study of collections of coccoid algae in numerous American and European herbaria, the original and type specimens of a considerable proportion of the described species have come to our attention. The following transfers have become necessary to the construction of a system of nomenclature expressive of the biological relationships of the algae concerned and, at the same time, acceptable under the present International Rules. Explanation and application of the names herein proposed will be dealt with fully in a revision of the Chroococcaceae and Chamaesiphonaceae to be published in the near future.

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